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ABSTRACT

This bibliography is designed to be as comprehensive as possible on the effects of nutrition on learning. While a few of the citations are relatively old, they represent the beginning of research interest in the area. Most of the citations are from the late 1960's or early 1970's. Much of the research in the area uses animals as subjects, rather than children. For the most part, citations dealing with animal research have been omitted. A few representative studies of biochemical research are included. In preparing this bibliography, two computer generated searches were made on ERIC tapes, with a manual update through June, 1972. Each citation is abstracted. A short paper summarizing the citations in the bibliography precedes the bibliography and was written as an introduction to the area, rather than as a comprehensive discussion of the findings. An author index follows the bibliography. (Author/DJ)

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MALNUTRITION, COGNITIVE DEVELOPMENT, AND LEARNING

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A NOTE ABOUT THIS BIBLIOGRAPHY

This bibliography is designed to be as comprehensive as possible on the effects of nutrition on learning. While a few of the citations are relatively old, they represent the beginning of research interest in the area. Most of the citations are from the late 1960's or early 1970's. Much of the research in the area uses animals as subjects, rather than children. For the most part, citations dealing with animal research have been omitted. Another very prolific research area involves biochemical studies which deal with the effects of various specific vitamin and mineral deficiencies rather than with a more global type of malnutrition. A few representative studies of this kind have been included.

In preparing this bibliography, two computer-generated searches were made on the ERIC tapes, with a manual update through June, 1972. One search was done by Bradley University, Peoria, Illinois using descriptors, and one by the Lockheed Corporation's Dialog system using identifiers. Also searched were the Exceptional Children tapes, based on the collection of the ERIC Clearinghouse on Exceptional Children; and literature on the Medlars tape through July 1972 from the National Library of Medicine, Bethesda, Maryland.

Library searches included Biological Abstracts, Psychological Abstracts, Dissertation Abstracts, and the Education Index. Manual searches were also made through the local collection of the ERIC

Clearinghouse on Early Childhood Education, and the card catalogs at the National Library of Medicine and the University of Illinois Libraries.

Dr. Merill S. Read, Director, Growth and Development Branch, National Institute of Child Health and Human Development generously opened his personal literature files, and provided copies of two manuscripts currently in press.

Stephen Robinson, graduate student in Educational Psychology at the University of Illinois wrote some of the nutrition abstracts, and supplied references in the area.

A short paper summarizing the citations in the bibliography precedes the bibliography and was written as an introduction to the area, rather than as a comprehensive discussion of the findings. An author index follows the bibliography.

MALNUTRITION, COGNITIVE DEVELOPMENT, AND LEARNING

Increased interest in the effects of nutrition on intellectual development and learning has resulted in with an upsurge of research in the last decade. Much of the research has been done with animals in experimental-laboratory type situations, or with children from other countries, such as Africa, Asia, and Central and Latin America. Very few of the studies have been done in the United States, although the trend seems to be for more studies to be undertaken in this country. An impetus for research in this country has been the Head Start program, with its concomitant emphasis (in many programs) on sound nutrition as a basis for efficient and effective learning.

Cravioto, DeLicardie, and Birch (1966) suggest that malnutrition can act in two ways: directly by interference with the central nervous system, and indirectly through interaction with social and environmental factors, including loss of learning time due to apathy and sluggishness, and through personality and motivational changes, as a result of child-adult interaction. Often an adult will reject an apathetic or sluggish child because of his behavior, thus compounding the biological problem of malnutrition with the social and psychological factors of rejection and lessened social interaction.

Research indicates that severe malnutrition with hospitalization has a long term persistent effect on measured intelligence, and on the learning of such basic academic skills as reading and writing (Cravioto

and DeLicardie, 1970). Children who suffer from severe malnutrition early in life are handicapped educationally as well as socially. Because of the increased risk of becoming a poor reader, a poor writer, and subsequently a failure in school, the child functions at a suboptimal level. Children who survive bouts of severe malnutrition are therefore more likely to be victims of their poor socioeconomic environment, being less than normally effective in their social adaptations. In addition, children who function marginally grow into adults who function marginally. They marry and raise families in the same tradition, thus perpetuating the cycle of poverty, malnutrition, retarded learning, and intellectual development.

Although severe malnutrition in the United States is rare, moderate malnutrition (cases not severe enough to be hospitalized) is suggested as a contributing factor to the higher morbidity and mortality rates found among low income groups (Birch, 1968b). Although severe malnutrition has been found to be a causative factor in retarded intellectual development, the exact outcomes of moderate malnutrition have as yet to be determined. It has been suggested that psychological, social, and cultural factors act synergistically with malnutrition to produce retarded intellectual development as well as learning disabilities. Just what effect each factor has must be determined. However, it is known that malnutrition does play a role.

Malnutrition: What Is It?

Read (1969) defines malnutrition as a state in which an individual lacks one or more nutrients to such an extent that specific symptoms and conditions appear: anemia, goiter, rickets, vitamin deficiencies, or

retardation in physical development. In school, undernourished or hungry children frequently exhibit behavioral alterations, including apathy, lethargy, inability to pay attention and perhaps overconcern about food to such a degree that responses to classroom stimuli do not occur. A child in such a condition no longer meets the expectations of his family or teachers. He begins to live in a world of his own and may seek recognition or try to gain attention in ways that disrupt learning experiences. Parents and teachers may react to his social behavior and withdraw some of the stimulation necessary for adequate mental development.

Research on malnutrition will often deal with a specific kind of malnourishment. Two kinds commonly studied include marasmus (or nutritional marasmus), and kwashiorkor. The term "marasmus" applies to young infants who have experienced protein-calorie malnutrition with general body wasting. It entails the severe inadequacy of all nutrients, usually from the earliest months of life, and produces infants whose physical development is grossly impaired. It is a long term condition, beginning early, and is thought to be irreversible. The term "kwashiorkor" indicates an affliction among older infants and young children who have been maintained on low protein, but modest calorie intake diets, with accompanying edema and other problems. It is basically the insufficiency of protein, and typically occurs toward the end of the first year, or during the second year of life. It often occurs after the birth of a younger sibling, when the sibling is being nursed rather than the older child.

Marasmus appears to be a more severe form of malnutrition, since it occurs in the younger child whose brain is developing at a more rapid

rate. Research has indicated that kwashiorkor is not necessarily associated with permanent intellectual damage, at least if the child was older than twelve months when the condition began (Pollitt, 1970).

Contributing factors

How do the outcomes of malnutrition vary as a function of age of onset, severity, duration, and type of malnutrition? These are but a few of the concerns addressed by the researchers in the area. Age of onset of malnutrition is an important factor, since by the time a child is one year old, the brain is about 70% of the size of that of an adult; by the age of four, brain growth is almost complete. Results of animal experiments lend support to the hypothesis that the greatest effect of malnutrition on ultimate size and performance of the mature individual is produced during the period of maximum growth. There is a great possibility that at least children severely malnourished during the first six months of life might retain a permanent mental deficiency.

Research by Chase and Martin (1970) has indicated that there is a critical time for the onset of malnutrition, as well as for duration. They evaluated the psychomotor development of 19 children some 3 1/2 years after they had been hospitalized for "generalized malnutrition" during the first year of life. These children were compared with 19 controls who were adequately nourished all their lives. The psychomotor development of children hospitalized before four months of age did not differ significantly from the controls in the study. However, those malnourished children hospitalized after four months of age, who presumably suffered longer from malnutrition, performed at a significantly lower level than either the control children or the malnourished children hospitalized prior to

four months of age. These significant performance decrements were found in five areas: gross motor development, fine motor development, adaptive behavior, personal-social development, and above all, language development.

Naeye (1970) suggests that the age at which malnutrition occurs is important since the brain is more sensitive to nutritional deficiency at the time of the most rapid cell division. He found that diet therapy started before the age of four months was more effective than treatment begun between four and twelve months. In a review of the literature, Birch and Grotberg (1971) suggest that the effects of inadequate nutrition on growth and development depend to a large extent on the severity, timing (pre- and postnatal), and duration of the nutritional deprivation. Botha-Antoun (1968) suggested that the greatest effects of undernutrition on mental and physical development may be produced at periods of maximal growth, and probably will not be reversed with later adequate nutrition. He studied children who had been malnourished between three and eighteen months, focusing on the later effects of malnutrition on intellectual performance and psychomotor activities. He found that the average IQ was lower for the malnourished children, and that the age of walking and talking were later. Cravioto, DeLicardie, and Birch (1966) found that intellectual development in malnourished young children was related to the age of the child at the time of affliction and to the duration of the malnutrition. Performance on psychological tests was related to nutritional factors.

Klein (1969) suggests that the central nervous system may be particularly susceptible to the effects of malnutrition during the last

trimester of pregnancy and the first six months of life. The effects of malnutrition seem to vary inversely with the age of onset and directly with its duration and severity.

To summarize, research studies point up the importance of several factors concerning malnutrition. The earlier the child is malnourished even beginning during the last trimester of pregnancy, the more severe the effects usually are. Severity of the malnutrition also dictates the child's intellectual development, since early, severe forms of malnutrition generally bring about more retardation, both physical and mental. Duration is an important consideration in the study of malnutrition, since the longer a child is malnourished, especially if the malnourishment begins at an early age, the more severe, and sometimes irreversible, are the effects. Type of malnutrition is also a consideration since marasmus, which strikes younger infants, generally causes more damage than kwashiorkor, which strikes older infants.

What Are the Effects of Malnutrition?

A study of the effects of malnutrition raises questions like these: Is the retardation permanent or reversible? What areas or abilities are affected? What are the contributions of environmental and sociocultural factors?

Frisch (1970) suggests that the difference in reversibility of the effects of malnutrition seems to be related to the age at which the child is affected. It appears that the greatest risk of irreversible brain damage occurs in children who suffer deprivation before birth or shortly thereafter. Winick (1968) suggests that a low protein diet stunts the brain as it stunts the rest of the body, and that damage done to the brain

of a human infant may be irreversible if malnutrition occurs before six months of age. Eichenwald and Fry (1969) suggest that inadequate protein nutrition or synthesis, or both, during brain development results in changes in function, and that, if the degree of deprivation were sufficiently severe and prolonged, the change in function might be permanent.

Latham (1969) cites a study in which malnourished children who received nutritionally adequate diets, gained an average of 18 points on IQ tests, while the well-nourished children who were used as a control group showed no gain. He suggested that because of dietary deficiencies the malnourished children had not reached their full potential and that correction of deficiencies resulted in a rise in IQ, whereas the well-nourished control group children showed no changes over the same time period. Lederberg (1968) suggests that stunted physical growth due to malnutrition in childhood is beyond the reach of an adequate diet in later life, and that mounting research evidence indicates that the same may be true for mental development.

Monckeberg (1968) followed Chilean infants who had been malnourished for several years. Results of physical and psychological tests led to the conclusion that brain damage in infancy is permanent up to the sixth year of life, despite improving nutritional conditions.

Osofsky (1969) reports a study in which malnourished infants were followed up eleven years later. He suggests that malnutrition affects intellectual development, and is apparently irreversible in the age group studied. Eleven years later the children had difficulty in visual-motor ability and pattern perception, and in many ways resembled brain

damaged children.

Rajalakshmi (1968) points out that nutritional remediation alone is not sufficient to overcome the effects of malnutrition and mental retardation in children whose social and cultural environments are totally lacking in emotional and psychological stimulation.

Rendon (1969) reports a study with eighteen malnourished hospitalized children and eighteen controls, which revealed that the malnourished children evidenced noticeable deficiencies in anthropometric measurements, development, and functioning levels. Deficiencies in all areas of infant mental development and especially in the development of language and social-personal attitude persisted even after nutritional recovery was satisfactory. He suggests that the deficiencies of the malnourished group cannot be attributed solely to reduced protein and calorie intake because of multiple interrelated factors, such as the lack of environmental stimulation, extreme poverty, poor parent education, and parent intelligence. Sandstead et al. (1971) suggest that other compounding factors include a marginal family income, a lack of parental understanding of nutrition, and a lack of parental supervision, particularly at mealtime. Scrimshaw (1968) suggests that psychological and social deprivation is also common among malnourished children, and can exert a direct influence on intellectual performance. He suggests that malnutrition can interact with heredity, infection, social and environmental factors to bring about physical and mental impairment.

It thus appears that if the malnutrition occurs during early infancy, the damage is probably irreversible. It also appears that

virtually all areas of human functioning are affected by malnutrition and the accompanying social and environmental variables. However, it should be remembered that malnutrition does not occur in a vacuum, and that, especially in cases of moderate malnutrition, cultural, social, and environmental factors are also important.

Considerations in Nutrition Research

Klein and Yarbrough caution in regard to the many confounding variables in studying the effects of malnutrition. These variables include social class and child rearing practices, hospitalization, and medical factors such as intra-uterine infection and perinatal anoxia. Another complication in research on the effects of malnutrition and mental development is the appropriateness of the tests, especially those which are written and normed in one culture and used in another. Another consideration is the appropriateness of the control group, because often social and environmental factors are also at work on those children who are malnourished.

It thus appears that there are many difficulties in evaluating the effects of nutrition on cognitive development, since mental and social development are not singly determined but rather, multi-determined traits. Malnutrition is one of many adverse environmental effects impinging on the child; others include mother's health and nutritional status, birth injury, pre- and postnatal infections, and complex social and psychological deprivations.

In setting up a study, the researcher must find an adequate control group so he can make meaningful comparisons. In selecting a population the younger the child, the better. The effects of malnutrition seem

to vary inversely with the age of onset of malnutrition and directly with its duration and severity (Klein, 1969). Children should probably be studied from birth on, since they may suffer from other injuries, especially in an impoverished environment.

Selection of tests should be on theoretical grounds which reflect both the researcher's framework for conceptualizing the effects of malnutrition, and his theoretical point of view on cognitive development.

Very often sensory motor scales are used to assess mental development in infancy. However, in selecting this type of test, the researcher is making the assumption that the child's level of sensory-motor development is a valid and reliable index of infant intelligence--an assumption which is generally unfounded.

Traditional IQ tests tell little about the relationship between malnutrition and mental development since most IQ tests are global measures, giving little information about problem-solving, response style, linguistic competence, perception, and memory. Ginsberg (1972) has an excellent discussion of this topic in his book, The Myth of the Deprived Child.*

Studies of malnutrition have typically been conducted in underdeveloped countries. Generally these countries are culturally and linguistically different from the country in which the test was developed and normed. It thus appears that most existing measures of intellectual development are inappropriate for use in underdeveloped countries, unless they have been constructed for a particular country's

*Ginsberg, H. The Myth of the Deprived Child: Poor Children's Intellect and Education, Englewood Cliffs, N.J.: Prentice-Hall, 1972.

population.

Social and cultural factors may confound research on the effects of malnutrition. Socioeconomic status differences are important considerations, since it has been shown that working class mothers systematically treat children differently than middle class mothers do. Differences in intellectual development associated with dissimilar styles of child rearing can be detected early in infancy (Pollitt, 1969).

Thus, in designing research in the area of the effects of malnutrition on mental development, one must remember to consider the entire individual, including his complex inner functionings and his societal relationships, in trying to determine the role malnutrition plays in his life. Klein (1969) suggests there are six factors to be considered in designing studies: 1) an adequate control group; 2) supplemental feeding, so that both the experimental and control groups will be adequately nourished at the time of the study; 3) careful institution of the feeding program so that social variables are not confounded; 4) very young children, preferably newborns, as the population; 5) appropriate tests (theoretically relevant and culturally appropriate); and 6) measurement of family characteristics.

There appear to be two types of study designs in the literature: retrospective and perspective studies. Retrospective studies define children who have been malnourished as compared to those who were not. They are able to use large numbers of subjects in a relatively short period of time, and contain a peer definition of the nutritional state during the critical period being examined. Controls must also be selected on the basis of nutritional history and may in themselves have been

inadequately nourished. Perspective studies have fewer children, but the children are evaluated nutritionally by the researchers. This evaluation offers better nutritional information and selection of controls at the time the study population is defined.

Recommendations for Future Research

Birch and Grotberg (1971) suggest that an adequate state of nutrition is necessary for good attention and for appropriate and sensitive responsiveness to the environment. It appears from the research that women who were malnourished as children are more likely to have disturbed pregnancies and children of low birth-weight, and increased risk of neuro-integrative abnormality. However, in cases where environmental, cultural, and social factors contribute much to the malnourished state, the emphasis in the programs should be an effort to improve the overall conditions of disadvantaged children.

Foster (1972) suggests that food programs are important aspects of the day care programs. Concern about inadequate nutrition in the day care centers came about in part because of research indicating the relationship of intellectual development and infectious diseases to adequate nutrition. Breakfast, lunch, and nutritious snacks will help raise a child's resistance to disease and may also bring about motivational changes by increasing a child's responsiveness to stimuli. A food service program of a day care center can also provide a laboratory for learning about food, nutrition, and socialization.

Project Head Start has helped provide information about nutrition and nutritious food to thousands of children and their parents across the country. However, North (1968) suggests that these various feeding and education programs now need to be evaluated.

Some of the problems associated with preschool malnutrition include the mother's lack of proper foods for optimal growth and development; the high cost of protein rich foods necessary for optimal early development; and lack of transportation of food and proper food processing or preservation. Some of the problems can be overcome through educational programs such as those associated with day care programs. However, broader federal programs will probably be necessary to overcome the food cost and transportation problems.

Future research should also include more longitudinal studies exploring the effects of malnutrition and mental development, taking into consideration the many factors discussed above.

Summary

Research indicates that good nutrition is of major importance in the physical development of the brain, and enables a child to benefit optimally from the environmental stimulation necessary for cognitive development. Most evidence suggests that malnutrition during the earliest months causes, or contributes to, retarded mental and physical development. If malnutrition occurs after the first year, subsequent adequate nutrition can often bring the child closer to his capabilities. Factors important in the study of malnutrition include age of onset, severity, duration,

and type of malnutrition. Also of concern is whether the effects of malnutrition are reversible or permanent, just what areas or abilities are affected, and the contribution of the culture and the environment.

In reading studies in the area of malnutrition and mental development, one should carefully consider the methodology, including the appropriateness of the tests and the control groups, before accepting the conclusions as fact.

Future research and concern should include more carefully controlled studies attempting to relate malnutrition and mental development, and establishment of education programs in day care centers to reach disadvantaged populations. Federal programs are also needed to help with the problems of food cost and availability.

MALNUTRITION, COGNITIVE DEVELOPMENT, AND LEARNING: A BIBLIOGRAPHY

1. Abelson, P.H. Malnutrition, learning, and behavior. Science, 1969, 164(17), 17.

Children reared in poverty tend to do poorly on tests of intelligence, partly because of psychological and cultural factors, but often because of malnutrition in early childhood. At present, it appears that millions of children in developing countries are experiencing some degree of retardation in learning because of inadequate nutrition. This phenomenon may also be occurring in the United States. It is difficult to isolate and assess the dietary deficiencies in man, but animal studies and observation of humans in developing countries have provided substantial evidence of the effects of malnutrition. Data from animal experiments suggest that it is particularly important for humans to have good nutrition during the first three years of life. Lack of animal protein is usually the most serious problem for humans. However, many people who have adequate caloric intake (primarily from low-cost foods) may be malnourished. It is important to differentiate between malnutrition due to inavailability of food and malnutrition due to choice of food. In the United States, children are more likely to be malnourished because of a lack of necessary nutrients in the inexpensive and convenient foods often purchased by parents.

2. Adams, R.N. Cultural aspects of infant malnutrition and mental development. In N.S. Scrimshaw & J.E. Gordon (Eds.) Malnutrition learning and behavior. Cambridge, Mass.: M.I.T. Press, 1968, Pp. 465-474.

The author poses the question "How do culture and society affect culture and society when mediated by nutrition and human growth and development?" He suggests that the study of the relation between infant malnutrition and mental development should be approached on a broad framework, embracing the full adaptive cycle. Cultural factors play a role in a differentiation of both independent (those factors believed to affect growth and development of the individual or of the culture at a later point in time) and dependent (e.g., culture content, psychological potential) variables. Evidence exists that sociocultural conditions lead, on occasion, to mental deficiencies. In addition, specific forms of malnutrition have that capacity. The author contends that the ultimate goal of the research is better adaptation of man to the world, a concern that currently has too little attention.

3. Aldrich, R.A. Nutrition and human development. Journal of the American Dietetics Association, 1965, 46, 453-456.

This article is based on a speech presented by the author, who was Director of the National Institute of Child Health and Human Development at the time of the speech. He outlined the responsibilities of NICHD in the study of human development. In particular, he reviews NICHD's commitment to studying the effects of nutrition on human development.

4. Altman, J., Das, G.D. & Sudarshan, K. The influence of nutrition on neural and behavioral development: I. Critical review of some data on the growth of the body and brain following dietary deprivation during gestation and lactation. Developmental Psychology, 1970, 3(4), 281-301.

This article briefly reviews the scanty data available on the effects of undernutrition during gestation and lactation upon neural development in man. The review is followed by a description of the various techniques which have been employed for the experimental undernutrition of laboratory animals. A detailed review is then given of the effects of dietary deprivation of the nervous system and its different parts in a variety of mammalian species, with special emphasis on the rat. Finally, the developmental phases during which undernutrition can be produced experimentally are related to critical stages of vulnerable periods of brain development.

5. Bailit, H. & Whelan, M.A. Some factors related to size and intelligence in an institutionalized mentally retarded population. Journal of Pediatrics, 1967, 72, 897-909.

A sample of 77 institutionalized children diagnosed as mentally retarded without other neurological signs or symptoms (familial-cultural) was examined anthropometrically; additional data gathered included I.Q., birthweight, parental age, birth order, age at admission, and length of time spent in the institution. The results indicated that the sample subjects were retarded for all measurements; those heavier at birth were larger and more intelligent; and length of time spent in the institution was not found to influence growth or I.Q. There was no evidence for a progressive retardation in growth or intelligence with increasing age relative to normal standards.

6. Bakan, Rita. Malnutrition and learning. Michigan State University, Center for Urban Affairs Report #RR5, 1971. (ED 051 321, 12p.)

The characteristics of malnourished children bear a striking resemblance to a number of the known characteristics of "disadvantaged children," e.g., apathy, irritability, sickliness, and a reduced attention span. The combination of malnutrition and the other negative effects of poverty perpetuates the cycle of illness, educational failure, and more poverty. If the aim of compensatory education is to break this cycle, then it is imperative that social scientists and educators become aware of the negative impact of malnutrition on the development of the child. Perhaps most specific to education is the demonstration of delayed neurointegrative development in children who have grown poorly because of malnutrition. Inadequacies of intersensory development can contribute to a child's failure to establish an ordinary normal background of conditioning in his preschool years, as well as the risk of failure to profit from educational experience in the school years. Remediation suggested includes nutrition education and provision of breakfasts and lunches for preschool children.

7. Barnes, R.H. Effects of malnutrition on mental development: Truths and half-truths. Journal of Home Economics, 1969, 61(9), 671-676.

These experiments provide evidence that animals malnourished during early periods of life are very severely affected in terms of intelligence or ability to learn, and level of emotionality. Evidence from these animal experiments indicates that early malnutrition can have an effect on emotional behavior, but as yet no one has looked at this kind of behavior in human beings. Evidence is beginning to show that if malnutrition is started early enough in life (probably no later than 6

months of age in humans), and if it is severe and continues long enough, a decrease in the capacity to learn may result. The author emphasizes that the malnutrition imposed on the experimental animals is much more severe than is usually seen in malnourished poverty groups in this country. No evidence suggests that chronic malnutrition of a milder sort, the kind seen extensively in poverty groups in this and other countries, has direct effect upon the mental development of the child.

8. Barnes, R.H. Malnutrition in early life and mental development. New York State Journal of Medicine, 1965, 65, 2816.

Evidence from animal and human studies shows that in acute stages of malnutrition, behavioral abnormalities and low scores on psychological development tests are evident. Age of onset and type of malnutrition influence recovery.

9. Barnes, R.H., Moore, A.U., Reid, I.M., & Pond, W.G. Learning behavior following nutritional deprivation in early life. Journal of the American Dietetics Association, 1967, 51(1), 34-39.

The results of animal studies investigating the relationship of malnutrition and learning behavior are described. Pigs, malnourished in early life, were unable to extinguish a conditioned response, although both the malnourished and controls were able to develop this response at the same rate. Rats, nutritionally deprived during nursing, made significantly more errors than controls in a water maze test. Rats deprived during the post-weaning period as well as during nursing made the most errors.

10. Barrera-Moncada, G. Studies of alterations in growth and psychological development in the kwashiorkor syndrome. Caracas: Editora Grafos, 1963.

A study conducted in Venezuela in the early 1960's dealt with 60 children between 15-71 months of age hospitalized for severe malnutrition, primarily kwashiorkor. When examined after 7-12 weeks of treatment, these children had a mean Developmental Quotient (DQ) of 65 on the Gesell scale. Some of these children were reexamined 2 years later and achieved DQ's approaching the normal range. It was suggested that malnutrition may have cumulative effects since the older the child when studied, the more marked were the deficits.

11. Benton, A. Mental development of prematurely born children: A critical review of the literature. American Journal of Orthopsychiatry, 1940, 10, 719-746.

The review suggests that while there are a few sound and careful studies, many have methodological flaws. Therefore, the findings can only be considered as merely suggestive because of the defects of technique. Benton concludes that the studies show that prematurely born children demonstrate developmental retardation during the first two years of life, that they do catch up with full term children, that they are not inferior to full term children with respect to intellectual development, that birth weight, within the range indicated (1000-2500 grams), is not of great significance in relation to the mental development of children surviving the first year of life, and that the incidence of "nervous traits" or behavioral difficulties appears to be definitely higher among prematurely born than among full term children.

12. Birch, H.G. Field measurement in nutrition, learning, and behavior. In N.S. Scrimshaw & J.E. Gordon (Eds.) Malnutrition, learning, and behavior, Cambridge, Mass.: M.I.T. Press, 1968, Pp. 497. (a)

Some specific questions in regard to malnutrition and mental development are raised. Quantitative determinations of the frequency and extent to which malnutrition affects learning and behavior; the relative significance of malnutrition among other causative factors; the ages when malnutrition has most effect on mental development; and the mechanisms by which malnutrition exerts its action are among topics discussed. It is suggested that tests must be developed to sensitively measure behavioral differences, and yet such tests must be relatively insensitive to cultural differences between populations.

13. Birch, H.G. Health and the education of socially disadvantaged children. Developmental Medicine and Child Neurology, 1968, 10, 580-599. Also presented at the Conference on Bio-Social Factors in the Development, and Learning of Disadvantaged Children, Syracuse, N.Y., 1967. (ED 013 283, 55p.) (b)

The poor health of the disadvantaged child is a primary variable in his educational failure. A review of health studies shows that Negroes, Puerto Ricans and Indians suffer from the greatest health problems. Health factors found to relate specifically to intellectual and educational deficits include prematurity, obstetrical and perinatal complications, birth weight, maternal physical characteristics and nutrition, and prenatal care. They also show that a systematic relationship exists after birth between a child's nutritional inadequacy and both neurological maturation and learning competency. Although severe malnutrition in the United States is rare, subclinical malnutrition among low-income groups (particularly iron deficiency) may be a factor in their higher childhood morbidity and mortality rates, as well as in the constitutional differences between Negroes and whites. Malnutrition and maldevelopment adversely affect the

disadvantaged child's nervous system and, therefore, his learning potential. Such impairment is a primary handicap which can be only partly remediated because the effects of a biosocial pathology cause disadvantaged children to suffer from lost learning time, nutritional deficit during critical learning periods, and adverse motivation and personality changes. In intervening to provide the best learning conditions for the disadvantaged child, educators should recognize the importance of the child's health to his learning effectively.

14. Birch, H.G. Malnutrition, learning and intelligence. American Journal of Public Health, 1972, 62(6), 773-784.

Nutrition of the individual is perhaps the most ubiquitous factor affecting growth, health, and development. Inadequate nutrition results in stunted growth, reduced resistance to infectious disease, apathy, and general behavioral unresponsiveness. Research indicates that malnutrition makes a significant contribution to depressed intellectual level and learning failure. Negative effects may be produced directly as a consequence of irreparable alterations of the nervous system or indirectly as a result of ways in which the learning experiences of the child may be interfered with at critical points in the developmental course. If a primary requirement for normal intellectual development and for formal learning is the ability to process sensory information and to integrate such information across sense systems, the evidence then indicates that both severe acute malnutrition in infancy and chronic subnutrition from birth into the school years results in defective information processing. Malnutrition generally occurs in

conjunction with low income, poor housing, familial disorganization, and a climate of apathy, ignorance, and despair. Just improving nutritional status cannot therefore fully solve the problem. Effects must be aimed at improving all aspects of the lives of disadvantaged children.

15. Birch, H.G. & Cravioto, J. Infection, nutrition and environment in mental development (human). The prevention of mental retardation through control of infectious diseases. Proceedings of a conference, June, 9-11, 1966. Cherry Hill, N.J. National Institute of Child Health and Human Development, Public Health Service; Bethesda, Md. U.S. Public Health Service Publication #1692. Pp. 227-248.

An ecological approach was adopted to study the relation of infection to mental subnormality. This approach focusses on 3 interrelated events; the agent, the host organism and the host's environment. The effect of malnutrition and cultural and psychosocial factors are discussed.

16. Birch, H. & Grotberg, E. (Eds.) Design and proposal for early childhood research: A new look: Malnutrition, learning and intelligence, Office of Economic Opportunity, Office of Planning, Research, and Evaluation, 1971. (ED 053 811, 38p.)

A survey of the evidence shows that some degrees of malnutrition are relatively widespread among poor children. However, the effects of inadequate nutrition on growth and mental development depend to a large extent on the severity, the timing (pre- and postnatal), and the duration of the nutritional deprivation. The data are inadequate on the true prevalence of malnutrition among children in this country, and there is even less information about its onset or about its severity and quality. The absence of such knowledge reflects not the absence of the problem but the lack of attention devoted to it. There are strong indications that

nutritional factors at a number of different levels contribute significantly to depressed intellectual level as well as learning failure. Moreover, an adequate state of nutrition is necessary for good attention and for appropriate and sensitive responsiveness to the environment. Further, women who were malnourished as children are more likely to have disturbed pregnancies, children of low birth weight, and increased risk of neuro-integrative abnormality. It must be recognized, however, that the improvement of nutrition alone cannot fully solve the problem of intellectual deficit and school failure. Rather, an overall effort to improve the conditions of disadvantaged children is required.

17. Birch, H.G. & Gussow, J.D. Disadvantaged children: Health, nutrition, and school failure. New York: Harcourt, Brace & World, 1970.

The authors review studies in the area of malnutrition and its effects on growth and school learning. They suggest that in addition to the nutritional deficiencies, there are also the confounding factors of social conditions, environment, infectious diseases, and social customs and traditions, including child rearing practices. Programs of educational intervention for disadvantaged children may fail if the many confounding variables are not taken into consideration. The authors suggest that their book was written to provide an awareness of the scope of the problem confronting children born of and into poverty--and perhaps help break the cycle.

18. Botha-Antoun, E., Babayan, S., & Harfouche, J.K. Intellectual development related to nutritional status. The Journal of Tropical Pediatrics, 1968, 14(3), 113-115.

The greatest developmental effects of undernutrition in early childhood may be produced at periods of maximal growth. Most brain growth and much mental development take place in the first two years of life. Therefore, it is probable that adverse effects on mental functioning during the first years will not disappear as a consequence of later adequate diets. The present study looks at the relationship of low nutritional status in the first 18 months of life to intellectual performance at age 4-5 years. Subjects and control group consisted of 44 children each, with matched parents in terms of age, intellectual performance, and educational level. All were born healthy and were not malnourished until at least three months after birth (when the mother started weaning the child). The mean I.Q. of the experimental group was 79.5 while that of the control group was 103. The mean age of onset of walking for the experimental group was 13.5 months, and for the control group, 11.8 months; talking for the experimental group was at 16.7 months, and for the control group 14.4. All differences were statistically significant.

19. Brockman, Lois M. The effects of severe malnutrition on cognitive development in infants. Cornell University, 1966, Ann Arbor, Mich.: University Microfilms No. 66-5504. (Doctoral dissertation.)

Twenty children, aged 12-43 months, who had been hospitalized for severe nutritional marasmus in Lima, Peru sometime between 2 1/2 - 42 months of age were the subjects in this study. The author attempted to assess cognitive functioning involved in primitive categorizing behavior in these infants by means of some simple sorting techniques (previously used with normal infants). The test performance of the male infants was substantially and significantly below that of a control group

of children from the Lima slums who had been selected on the basis of their being taller than the malnourished children and hence presumably without a previous history of severe malnutrition.

20. Brockman, Lois & Ricciuti, Henry N. Severe protein-calorie malnutrition and cognitive development in infancy and early childhood. Developmental Psychology, 1971, 14, 312-319.

In this study of cognitive development and malnutrition the effects of severe protein-calorie malnutrition during infancy were observed in the child's manipulative organization of sorting task objects. Twenty protein-calorie deficient children (experimental Ss ranging in age from 11.8 to 43.5 months, and 19 controls without a history of malnutrition) were tested with 10 different sorting tasks. Following 12 weeks of further nutritional treatment the experimental Ss were retested. Analysis of the total test scores indicated that the malnourished children performed significantly lower than the controls, and children under two years of age performed lower than children over two years old. On retest, the malnourished children showed no significant increase in test scores. Test scores of the experimental Ss were correlated negatively with all body measure percentages at admission, and positively with changes in body length and head circumference percentages between admission and first testing. Test scores also correlated positively with length of time in nutritional treatment, and medical ratings of nutritional recovery.

21. Bronfenbrenner, U. Early deprivations in mammals: A cross-species analysis. In G. Newton & S. Levine (Eds.) The psychobiology of development, Springfield, Ill.: Charles C. Thomas, 1968, Pp. 627-764.

The first half of the paper discusses early deprivation in such mammals as rodents, dogs, cats, and monkeys, while the second half deals with early human deprivation. The section on humans presents 20 hypotheses on the effects on development of early drive deprivation, particularly oral, contact, dependency, and perceptual-motor stimulation drives.

22. Brown, R.E. & Halpern, F. The variable pattern of mental development of rural black children. Clinical Pediatrics, 1971, 10(7), 404-409.

Four hundred and two black Mississippi children between the ages of one week and three years were tested to determine mental development. Children in this group, deprived both nutritionally and environmentally, performed poorly on the tests. The results were interpreted as showing that poor environment is as relevant as malnutrition for mental development in the first three years of life.

23. Brown, A.M., & Matheny, A.P. Feeding problems and preschool intelligence scores: A study using the co-twin method. The American Journal of Clinical Nutrition, 1971, 24, 1207-1209.

The present study used reported differences in eating habits in twins to show that subtle variations in the first year, an important period for brain growth and development, can be related to differences in mental abilities. The authors suggest that children who are "picky" or problem eaters are a cause for concern and that it is the child's restriction of his diet, rather than the tense, over-anxious mother as often suggested, which may be the source of nutritional deficiencies.

24. Brozek, J. Soviet studies on nutrition and higher nervous activity. Annals of the New York Academy of Science, 1962, 93, 665.

This review of Russian studies shows that these investigators have followed Pavlov's school of thought which inferred "cortical dynamics" from the properties of conditioned reflexes. The findings from these investigations suggest that when intake of a variety of essential nutrients is inadequate, changes in conditioned reflexes occur in advance of the development of clinical symptoms of severe malnutrition, and are reflected in modifications of acquisition rate, maintenance and extinction.

25. Bullard, D.M., Jr.; et al. Failure to thrive in the 'neglected child.' American Journal of Orthopsychiatry, 1967, 37(4), 680.

Non-organic causes of failure to thrive are discussed. Investigators have noted parental neglect and various forms of maternal deprivation as causes for failure in the children studied. Also cited are the needs for direct observations of feeding patterns and nutrient intake, and evaluation of the interaction of child and parents in the home.

26. Cabak, V. & Najdanvic, R. Effect of undernutrition in early life on physical and mental development. Archives of Diseases of Children, 1965, 40, 532-534.

Study results showed that Serbian children with a history of marasmus had significantly lower intelligence quotients than Serbian children in general. However, no real attempt was made to control environmental factors, except that controls were of the same racial or genetic stock. One important aspect of this particular study is that it was concerned with malnutrition during the first year of life. (Precise time distinctions are not often made in studies investigating

malnutrition in childhood.) This study also demonstrated one of the largest intelligence quotient deficits of any of the investigations, and the children studied were at the youngest age when nutritionally deprived. A major weakness in this investigation was the lack of an adequate control group. The control children not only were better nourished but came from better socioeconomic conditions.

27. Canosa, C.A. Ecological approach to the problems of malnutrition, learning, and behavior. In N.S. Scrimshaw & J.E. Gordon, (Eds.) Malnutrition, learning, and behavior. Cambridge, Mass.: M.I.T. Press, 1968. Pp. 389.

The paper reviews some of the complexities and planning aspects of field studies dealing with malnutrition, learning, and behavior. It is based on a prospective long term study that began in 1964 at the Institute of Nutrition of Central America and Panama with field operations in Guatemala. The main independent variable was the nutritional state of preschool children with mental development as the dependent variable. The study attempted to improve understanding of the relationships between malnutrition, learning, and behavior.

28. Canosa, C.A., Salomon, J.B., & Klein, R.E. The intervention approach: The Guatemala study. In W.M. Moore, M.M. Silverberg, & M.S. Read (Eds.) Nutrition, growth, and development of North American Indian children. Washington, D.C.: U.S. Government Printing Office, 1972. Pp. 183-199.

Evidence from studies with experimental animals suggests that both moderate and severe protein calorie malnutrition and critical periods can produce adverse changes in physical growth and mental development. Evidence from human studies also suggests that severe, long lasting protein-calorie

malnutrition in young children may be followed by modifications in behavior and mental performance. The present intervention study, conducted under very carefully controlled conditions, should provide much information on the interaction between malnutrition, behavior development, and the social factors in underdeveloped countries.

29. Carter, James; et al. Health and nutrition in disadvantaged children and their relationship with intellectual development. Demonstration and Research Center for Early Education and Vanderbilt University, School of Medicine, 1970. (ED 052 816, 73p.)

Health and nutritional status were assessed in three groups of Tennessee children (urban black, urban white, and rural white) who lived in an Appalachian type of environment. An attempt was made to relate aspects of physical status to intellectual adequacy as measured by the Stanford-Binet or the Wechsler Preschool and Primary Scale of Intelligence. The three target groups attended day care programs with a school lunch and snack program. A comparison group did not. Findings of interest were: 1) the general health status of children examined was not inferior on national norms; 2) there was a sufficiently high incidence of visual, auditory, and speech problems to warrant specific attention; 3) the composite specimen analysis technique was successfully used because it presented a precise picture of what a particular child ate rather than what he was served; and 4) no particular meaning was found in correlations between various indices of skeletal age, height, weight, bone density and indices of learning ability. The aim of the study was to provide descriptive information.

30. Champakam, S., Srikantia, S.G. & Gopalan, C. Kwashiorkor and mental development. American Journal of Clinical Nutrition, 1968, 21(8) 844-852.

This study was concerned with 1) developing suitable tests of mental development for children in the Telengana area of Andra Pradesh, India, taking into consideration the two languages spoken and the varied cultural environments of the two linguistic groups; and 2) the application of these tests to children who had recovered from kwashiorkor as well as to "normal" children in the community. Nineteen children who had been admitted to the hospital with kwashiorkor and had been successfully treated were the experimental group. All were between 18 and 36 months at the time of admission. The follow-up assessment occurred when they were between eight and eleven years of age. Three control children (matched in age, sex, religion, caste, socioeconomic status, family size, birth order and educational background of parents, and general pattern of care) from the same locality, in the same school and class were compared to each child in the experimental group. I.Q. test results showed a significant difference between the control subjects and those treated for kwashiorkor. The difference was most significant in the younger children (8-9 years of age) and tended to diminish in the older children (10-11 years of age). There was also a close direct relationship between intelligence scores and performance on the intersensory tests--both in experimental and control groups. Performance was poorer in the younger group, but tended to improve in the older group. The retardation was noticeable mainly with regard to perceptual and abstract abilities. However, it is difficult to assess the extent to which kwashiorkor was

the basis for lower intelligence scores. Factors of individual parental initiative to provide for their children, or immobilization during illness may have contributed to the retardation of the experimental group.

31. Chandra, R.K. Nutrition and brain development. Journal of Tropical Pediatrics, 1964, 10(2), 37-38.

The author reviews certain studies on nutritional deficits and subsequent effects on intellectual development and stresses the need for more research in this area.

32. Chase, H.P. & Martin, H.P. Undernutrition and child development. New England Journal of Medicine, 1970, 282(17), 933-939.

The authors report one of the most carefully conducted studies dealing with the effects of malnutrition in infants. The psychomotor development of 19 children was evaluated some 3 1/2 years after they had been hospitalized for "generalized undernutrition" during the first year of life. Using the Yale Revised Developmental Examination, these 19 children were compared with 19 matched controls. The psychomotor development of subjects hospitalized before 4 months of age did not differ significantly from the controls in the study. However, those malnourished children hospitalized after 4 months of age (who presumably suffered longer from malnutrition) performed at a significantly lower level than both control children and malnourished children hospitalized prior to 4 months of age. These significant performance decrements were found in 5 areas: gross motor development, fine motor development, adaptive behavior, personal social development, and above all, language development. Social factors associated with undernutrition included paternal separation,

alcohol-related problems, inadequate money and many young siblings in the family.

33. Chaves, N. Nutrition and development of the brain. Review of Brazilian Medicine, 1968, 25(3), 169-173.

The effects of undernutrition and malnutrition on the nervous system, and myelinzation in normal cells and learning are discussed. Studies are cited concerning the effects of protein-calorie malnutrition and undernutrition upon the psychomotor development and I.Q. Also mentioned are some experimental reports about the correlation between RNA and DNA concentration in the brain and learning processes. Emphasized is the serious problem of severe malnutrition during pregnancy and early childhood in Northeast Brazil. Available evidence suggests that undernutrition and malnutrition during the first two years of life is related to deficiencies in learning and behavior.

34. Churchill, J.A. The relationship between intelligence and birthweight in twins. Neurology, 1965, 15(4), 341.

Fifty sets of twins were compared to determine the relationship between birthweight and WISC I.Q. The lighter twins were found to have lower I.Q.'s.

35. Cobos, F. Nutrition and psychological development: Speculative overview. Revista Interamericana de Psicologia, 1969, 175-188.

After pointing out the importance of malnutrition as a cause of physical and psychological devastation, this paper presents a review of the literature on the role of behavioral scientists in the study of the psychological and developmental aspects of malnutrition. The paper also

discusses some of the ways malnutrition and deprivation of food can alter the normal course of development. The integral role that feeding plays in mothering and maternal behavior and the difficulty of separating the effects of maternal deprivation from those of food deprivation are stressed. An explanation is offered in terms of Piaget's psychology of the possible deviation of behavior as an effect of malnutrition.

36. Cobos, F., & Guevara, L. Assessment of cognitive development in deprivation and malnutrition. In D.J. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.:Government Printing Office, in press. Pp. 274-305.

The following conclusions were made regarding the use of measurements of cognitive development in studying conditions of deprivation: 1) malnutrition is a limited area of the total picture of deprivation; 2) clinical malnutrition may be used as a parameter in studying deprivation and psychopathology in underdeveloped countries; 3) malnutrition and psychological status are merely areas in a large system of interactions; 4) degree of malnutrition will influence scores on intelligence tests, but will be only secondary to other influences such as social class; and 5) emotional changes accompanying deprivation are important but difficult to assess.

37. Coursin, D. Relationship of nutrition to central nervous system development and function. Federation Proceedings, 1968, 26, 134-138.

Nutritionally induced errors in metabolism are capable of causing central nervous system dysfunction. Early and prolonged undernutrition may limit or retard performance of the central nervous system. In developing countries where some 75% of the preschool children are undernourished,

a high morbidity and mortality rate exists. Those who do survive are often plagued by persistent parasitic infestations and recurrent infections. Research needs are discussed and the need for consideration of background as well as nutritional variables is emphasized.

38. Coursin, D.B. Undernutrition and brain function. Review of Nutrition Research, 1965, 26(1), 1-16.

Clarification of the relationship of nutritional deficiency to mental retardation is a challenge to researchers today. With better understanding, it would be possible to develop appropriate measures for prevention and correction to be instituted for preschool children in developing countries. If present estimates of the prevalence of undernutrition and possibly related subnormal brain function are valid, the upgrading of mental ability by 10%-20% could be a critical factor in bringing children of developing countries to a level of performance that would immeasurably advance their productive capacities for themselves and their nation.

39. Cravioto, J. Approaches to studies of malnutrition. In W.M. Moore, M.M. Silverberg, & M.S. Read, (Eds.) Nutrition, growth and development of North American Indian children. Washington, D.C.: U.S. Government Printing Office, 1972.

Three models for studying the effects of malnutrition are suggested: the deprivation model, the intervention model, and the natural history or ecologic model. Animal studies have used mainly the deprivation model, and are valuable in studying the human problem, since they permit an examination of the effects of malnutrition on biologic structures utilizing controlled conditions which would be impossible as well as immoral to

achieve with humans. Human studies use the intervention and ecologic models. The intervention approach is just the opposite of deprivation. It includes food supplementation, as well as infectious disease control, improved housing, educational and economic support, and increased opportunities for social learning. The ecologic approach attempts to tease out patterns of cause and consequences by considering the interrelations among food, health, and social factors over time.

40. Cravioto, J. The ecologic approach to the study of nutrition and mental development. In W.M. Moore, M.M. Silverberg, & M.S. Read, (Eds.) Nutrition, growth, and development of North American Indian children. Washington, D.C.: U.S. Government Printing Office, 1972. Pp. 169-184.

The purpose of this long term ecologic study was to clarify the relationship of physical and mental growth. A group of infants was selected and will be followed until the beginning of their formal school years. Numerous socioeconomic, medical, and anthropometric measures will be taken. Analyses will be made of the social environment in which early learning occurs; the biological, social and nutritional characteristics of physical and mental development; and the biological, social, and nutritional care of health and illness of these children during their first 7 years. The influence of varying degrees of malnutrition occurring at different periods on subsequent mental development will also be studied.

41. Cravioto, J. Ecologic study of child development with special emphasis on nutritional and social factors associated with mental development. Progress report, Mar 1970-Feb 1971, Dept. of Nutrition Children's Hospital of Mexico, PS 004 921.

This document is a progress report of an ongoing study of a one-year cohort of children born in a rural Mexican village. These children and their families are being closely observed from nutritional, pediatric, socio-economic and developmental points of view. The plan is to follow the children for seven years. Validated research instruments were used as feasible. Some cross-sectional studies using other children have already been done. Study results indicate that children who suffered from kwashiorkor requiring hospitalization before 30 months have I.Q.'s (at school age) which are significantly lower than those of their siblings who have not had the disease. [Pages missing from document]

42. Cravioto, J., Birch, H., DeLicardie, E., Rosales, L., & Vega, L. The ecology of growth and development in a Mexican preindustrial community report 1: Method and findings from birth to one month of age. Monographs of the Society for Research in Child Development, 1969, 34(5), 1-76.

The report described a longitudinal analysis of the growth and development of infants in Mexican preindustrial community. The program was designed to assess and document the many interacting factors affecting progress of all newborns in a single village where malnutrition was prevalent. The factors associated with growth achievement at birth and with neonatal gains all appear to have the biologic condition of the mother as the mediating variable through which the size of the newborn and growth increments in the neonate are affected. Biologic characteristics of the mother vary with her social status; thus the environmental circumstances associated with it are linked to fetal and neonatal growth. The authors suggest that the characteristics of the newborn infant are intergenerationally determined, partly by the environmental conditions which influenced his

mother's growth when she was a child and partly by the contemporary circumstances which characterize the infant's own family circumstances.

43. Cravioto, J. & DeLicardie, E. Intersensory development of school-age children. In N.S. Scrimshaw, & J.E. Gordon (Eds.) Malnutrition, learning, andbehavior, Cambridge, Mass.: M.I.T. Press, 1968. Pp. 252-268.

The relationship between neuro-integrative function and malnutrition in a group of children in a Guatemalan village was studied. The shortest children were assumed to have experienced malnutrition because they showed a lag in development of intersensory competence. This lag was not evident in urban children studied who were assumed not to have suffered malnutrition. The results of an investigation of auditory-visual capacity of children in a Mexican village are also given. Height was used as a criterion of malnutrition. The taller group performed better than the shorter.

44. Cravioto, J. & DeLicardie, E.R. Mental performance in school age children: Findings after recovery from early severe malnutrition. American Journal of Diseases of Childhood, 1970, 120, 404-410.

Animal studies as well as research on children make it apparent that a period of severe nutritional deprivation at a time when the vulnerability of the nervous system is high may be the cause of measurable damage to the central nervous system. Data leave little doubt that severe malnutrition with hospitalization has a long-term persistent effect not only on measured intelligence but also in ability to learn such basic academic skills as reading and writing. By increasing the risk of becoming a poor reader and a poor writer, chronic severe malnutrition suffered early in life may be the basis of a developmental path characterized by neurointegrative defective functioning, school failure, and subsequent subnormal adaptive functioning. The chain of events produces an ecological

"spiral" effect in family and society. A low level of adaptive functioning, lack of modern knowledge, social custom, infection, or environmental insufficiency of food stuffs lead to malnutrition with a large pool of survivors who function in suboptimal ways. Such survivors are themselves more likely to become the victims of their poor socioeconomic environments, since they are less effective than normal in their social adaptations. In turn, they will choose mates of similar characteristics and may rear children under conditions and in ways fatally programmed to produce a new generation of malnourished individuals.

45. Cravioto, J., DeLicardie, E. & Birch, H.G. Nutrition, growth and neurointegrative development: An experimental and ecologic study. Pediatrics, 1966, 38, (Suppl. #2, Pt II), 319-372.

Twenty Guatemalan preschool children hospitalized for severe malnutrition in early childhood were studied. It was found that intellectual development was related to the age of the child at the time of affliction and to the duration of the malnutrition. Performance on psychological tests was related to nutritional factors, not to differences in personal hygiene, housing, cash income, or other social and economic variables. The performance of both preschool and school children in Mexico on the Terman-Merrill, Gesell, and Goodenough Draw-A-Man Test was positively correlated with body weight and body height. Results suggest that inadequacies in intersensory development can place a child at the risk of failing to establish an ordinary background of conditioning in his preschool years; thus in all probability he will fail to benefit fully from his educational experiences, especially during the early school years. It is suggested that malnutrition can act in two ways: directly by interference with the central nervous system, and indirectly in interaction with social and environmental factors.

46. Cravioto, J. & Gaona, C. Early malnutrition and auditory-visual integration in school-age children. Journal of Special Education, 1967, 2(1), 75-82.

To discover the relationship between early malnutrition and auditory visual integration, the tallest 25% and the shortest 25% of children between the ages of 7 and 12 in a rural village school in southwestern Mexico were tested for their ability to integrate auditory and visual stimuli by a method of equivalence. Short height was considered an indicator of early malnutrition. The 296 children were individually asked to identify visual dot patterns corresponding to rhythmic auditory patterns. Ability improved over the age span considered, with rapid improvement occurring between the ages of 9 and 11; at each age level the mean performance of the taller group was higher than that of the shorter. It was therefore suggested that early malnutrition producing integration difficulties may affect the child's ability to read, since reading requires the ability to transform temporarily distributed visual auditory patterns into spatially distributed visual ones.

47. Cravioto, J. & Robles, B. Evolution of adaptive and motor behavior during rehabilitation from kwashiorkor. American Journal of Orthopsychiatry, 1965, 35, 449-464.

Twenty infants hospitalized for severe protein-calorie malnutrition were tested with the Gesell infant scale every 2 weeks during treatment and rehabilitation, which lasted as long as 6 months for some infants. All infants were well below age norms on the Gesell when admitted (D.Q.'s mainly below 60). During rehabilitation 14 children who had been admitted for treatment between 15-42 months of age came progressively

closer to age expectations on the Gesell. However, the 6 infants whose malnutrition led to hospitalization before 6 months did not show any recovery of their developmental deficit during nutritional rehabilitation.

48. Cravioto, J. et al. The long-term consequences of protein-calorie malnutrition. Nutrition Review, 1971, 29, 107-111.

Research evidence indicates that the question of whether permanent stunting may be due to early malnutrition remains unanswered. At the present time there is insufficient data to distinguish between the contributing factors of early severe malnutrition, inadequate environment, and experiential opportunities in regard to defective cognitive function. It is most probable that both primary abnormality in the nervous system and defective experience are independent and interactive. However, the data leave little doubt that severe malnutrition with hospitalization has a long-term persistent effect not only on measured intelligence but also in learning basic academic skills. Survivors of early severe malnutrition are different from normal children.

49. Culley, W.J. Nutrition and mental retardation. In C.H. Carter (Ed.) Medical aspects of mental retardation. Springfield, Ill.: 1965, Pp. 88.

A review of studies of the relationship of nutrition to mental retardation, including the effect of protein, calorie and vitamin deficiencies on mental development, and a discussion of the nutritional problems of the mentally retarded child are presented.

50. Dayton, Delbert H. Early malnutrition and human development. Children, 1969, 16(6), 210-217.

This article is a review of several studies abstracted elsewhere in this bibliography. Based on the review, the author suggests that an assessment of the nutritional status of a population, including identification of deficiencies, is essential for sound social and economic planning. Nutrition education as well as better crop production are necessary for combating undernutrition and malnutrition in developing countries. He suggests there are many factors other than nutrition which can affect a child's mental functioning, including parent-child relations, parental expectations, intellectual stimulation, infectious diseases, parental intelligence, socio-cultural patterns, and other genetic and environmental factors.

51. Dean, R.F.A. The effects of malnutrition on the growth of young children. Modern Problems in Paediatrics. New York: Karger, 1960, 5, 111-122.

The author suggests that differences in physical growth, especially the extreme differences, are significant indirect indicators of malnutrition. He also points out that the earlier the malnutrition occurs and the longer it lasts, the more severe the effects.

52. The developing brain. Nature, 1969, 221, 808.

Professor A.N. Davison presents new evidence to suggest that there may be an intermediate stage in myelin synthesis. Thus, crude myelin isolated from homogenates of the developing brain can be separated into two factions--one comparable to mature myelin and the other with a lipid composition similar to that of plasma and other cell membranes. The process of myelination seems to be a "once and for all" event and once deposited

around the axon most of the myelin seems to be metabolically rather stable. Myelination may therefore be regarded as a vulnerable period of development because even mild undernutrition of amino acid or hormonal imbalance can permanently reduce myelin deposition in the brain. Much current research work is aimed at relating different types of protein to the function of identifiable brain structures.

53. Dobbing, J. Lasting deficits and distortion of the adult brain following infantile undernutrition. Paper presented at the Seminar on Malnutrition in Early Life and Subsequent Mental Development, Pan American Health Organization, Kingston, Jamaica, January 1972.

The evidence is clear that lasting structural changes in the brain are related to the timing of early undernutrition. The brain growth spurt is by far the most vulnerable period in terms of quantitative ultimate achievement and measurable physical distortion. Present research suggests that the brain growth spurt comes between the last trimester of gestation and the second year of life. Good nutrition during this period is central to proper growth. Malnutrition may well have lasting behavioral consequences.

54. Dobbing, J. Undernutrition and the developing brain: The relevance of animal models to human problems. American Journal of Diseases of Childhood, 1970, 120, 411.

Two main overlapping hypotheses are presented. The first, proposed by Winick and Noble, states that undernutrition during the growth period in any tissue when cell division is taking place will lead to permanent reduction in the number of cells attained. The second is that the brain is likely to be most vulnerable to permanent restriction from undernutrition

during the period of the "brain growth spurt." Corollaries and difficulties as well as evidence from animal and human studies are discussed. Three main conclusions have emerged so far: 1) DNA estimations reveal a separate growth spurt from 15 to 20 weeks of human gestation which is distinct from the main period of cell division. This latter extends from about 30 weeks of gestation to at least the end of the first postnatal year, and probably until 18 months of postnatal age. The early period is almost certainly neuronal; the later, glial. 2) Regional differences in growth rate, and the general sequence of events in human brain growth are identical with those in all animal species studied, except to timing of events in relation to birth. 3) The major growth spurt period in the human species is therefore predominantly postnatal, and this applies especially to the great bulk of myelin which has to be laid down after the arrival of the glial cells which make it. The period at which clinical undernutrition must be imposed in order to produce lasting intellectual deficit is also in accordance with the experimental and observational findings in the physical brain.

55. Dominquez, A.M. Modernization as a strategy in nutrition and mental development research. In D.J. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

Cultural differences compound the difficulty of studying nutrition and mental development. Three strategies are suggested for dealing with the problem: culture-free tests of performance, control of socio-cultural variables, and measurement of child's performance in "natural environment." Here the adaptation necessitated by modernization is important. Research strategies should center on the child as a social

individual. Techniques should be developed to observe him in his natural environment. One should use universal requirements of social living as dimensions for mental development evaluation: moral judgment, social creativity, general knowledge of his social system, and the nature and complexity of the strategies he devises for the attainment of his goals.

56. Eichenwald, H. & Fry, P.C. Nutrition and learning. Science, 1969, 163, 644-648.

For some time it has been acceptable to ascribe many behavioral characteristics to conditioning of the Skinnerian or Pavlovian type. However, recent research indicates that the conditioning may be biochemical, or caused by malnutrition, since the effects are physical as well as mental and emotional. Various animal studies have shown that inadequate nutrition (both calorie and protein) coinciding with the period in life in which the brain is growing most rapidly produces a smaller than normal brain which matures biochemically and functionally at a slower than average rate. Data also suggest that inadequate protein nutrition or synthesis, or both, during brain development results in changes in function. If the degree of deprivation is sufficiently severe and prolonged, the change in function might be permanent. Also discussed is the relationhip between nutrition, growth, infection and the environment. Environmental factors undoubtedly contribute significantly to the effects of malnutrition on behavior and function in humans. The intellectual attainments of children who have recovered from a clinically severe episode of protein calorie malnutrition are consistently lower than those of individuals with adequate nutrition during infancy.

57. Eisenberg, L. Child psychiatry: The past quarter century. Paper presented at 25th Anniversary Dept. of Psychiatry, McGill University, Montreal, Oct, 1968. (ED 027 951, 29p.)

Before 1940, the desirability of a multidisciplinary study of the child had been well established, and child guidance clinics had appeared. Until the 1960's however, the focus was on the clinical study of individual patients and families, rather than population studies, and generalizations were made from the former to the latter. Concern for the poor and the Black lay dormant for too long during the past quarter century since in areas such as poverty and racism serious psychological and organic problems occur in children. Specifically, research in child development must be concerned with many important factors, including 1) the test bias in interpreting results of achievement tests, 2) the prenatal and perinatal factors that influence brain development, 3) nutritional factors before and after birth, 4) the psychosocial environment of the child, especially the family environment, 5) the influence and role of school, and 6) the effects of racism.

58. Evans, D.E., Moodie, A.D. & Hansen, J.D. Kwashiorkor and intellectual development. South African Medical Journal, 1971, 45, 1413-1426.

Forty Cape Coloured children who had been hospitalized for kwashiorkor in infancy were compared with their siblings on an intelligence test battery at the tenth year of follow-up. No significant differences in intelligence test performance were noted. A significant discrepancy between the intelligence test score and the drawing score in late-onset cases may have been due to affective factors. The groups were similar in terms of height, weight, and head circumference. The differences

between the well-nourished and poorly nourished groups found by previous investigators may be accounted for by the non-nutritive variables in the social and emotional environment. The use of intrafamilial controls in the present study minimized both these influences and the possible influence of genetic factors in regard to intellectual development.

59. Foster, F.P. Nutrition and educational experience: Interrelated variables in children's learning. Young Children, 1972, 27(5), 284-288.

Research regarding the effect of malnutrition and hunger on intellectual development is producing a substantial body of evidence which indicates a direct relationship between inadequate diet and reduced learning power. The food program of the child care center is therefore approached with an awareness of its educational component. Concern about adequate nutrition in day care centers came about in part because of research indicating the relationship of intellectual development and infectious diseases to adequate nutrition. Malnutrition and hunger also produce behaviors which may interfere with learning, such as apathy, lack of initiative, and irritability. Breakfast, lunch, and nutritious snacks will help raise a child's resistance to disease and possibly bring about motivational changes by increasing the child's responsiveness to stimuli. Also, the food service program of a day care center can provide a laboratory for learning about food, nutrition, and socialization.

60. Friedman, S.B. Medical considerations in adolescent underachievement. Journal of School Psychology, 1971, 9(3), 235-240.

Traditionally the physician has not played a significant role in the multidisciplinary approach to the diagnosis and management of adolescents with learning disabilities. The paper discusses the potential contribution physicians can make in a multidisiciplinary team, and some changes taking place in the field of pediatrics in the management of school problems. Two medical factors, minimal brain damage and malnutrition, are specifically discussed as they relate to learning disabilities.

61. Frisch, R.E. Malnutrition and mental development: A critical review. Indian Journal of Nutrition and Dietetics, 1971, 8(3), 149-162.

Reviewed are recent studies of the mental testing of children who have been acutely or chronically malnourished since birth; results are compared with earlier findings. The evidence pointing to a possible relation between prenatal malnutrition and abnormal or subnormal mental development is also reviewed.

62. Frisch, R.E. Present status of the supposition that malnutrition causes permanent mental retardation. American Journal of Clinical Nutrition, 1970, 23(2), 189-195.

The difference in reversibility of the effects of malnutrition seems to be related to the age at which the child is affected. It appears that the greatest risk of irreversible brain damage occurs in children who suffer deprivation before birth or shortly after. However, the author suggests that conclusive and definitive studies have not yet been done in the area of malnutrition and mental development in humans.

63. Fritz, M.F. The effect of diet on intelligence and learning. Psychological Bulletin, 1935, 32, 355-361.

The author suggests that there is very little experimental evidence to indicate that diet markedly affects intelligence or capacity to learn. A child may be able to learn but lack the "drive," due to lassitude and ill health which may in turn be a function of diet. Experiments are needed to determine the effect of malnutrition upon the total behavior output. Such experiments need not involve the assumption that the nervous system will be structurally altered through dietary assault.

64. Frost, J.L. & Payne, B.L. Hunger in America. In Nutrition and intellectual growth in children. Washington, D.C.: Association for Childhood Education International, 1969, Pp. 5-18.

This article reports a number of malnutrition studies of children in Central and South America and some animal studies. Tunley states that a high proportion of the 2 million mentally retarded children in the U.S. are born to poor parents, and that many defects appearing in retarded children could be prevented by simple medication and treatment before birth. In another study, it was reported that prenatal care for mothers of disadvantaged children is almost non-existent. More stillborn and premature babies are born to these mothers than to well-fed mothers. The health of the mother may also affect the child after birth. Portions of the article dealt with the "Hunger of America" television special and the failure of the government to feed the hungry people in this country. Current data indicate that the younger the individual, the greater the likelihood that malnutrition will cause permanent physical and mental damage. Many factors contribute to malnutrition. These range from conditions not directly controllable by the poor, e.g., food scarcity, to conditions of ignorance fostered by the family, school, and other social groups.

65. Garrow, J.S. & Pike, M.C. Long term prognosis of severe infantile malnutrition. Lancet, 1967, 1(1).

Sixty-five Jamaican children who had been treated for severe malnutrition in hospitals were examined 2-8 years after their discharge from the hospital. They were found to be smaller by North American standards, but not when they were compared with Jamaican children genetically similar and coming from the same economic background. When 56 of the previously malnourished children were matched with siblings or close relatives as controls, they were slightly taller and heavier, broader in the chest, and had thicker bone and muscle in the leg than the siblings who had never been malnourished. There is no clear evidence that a period of severe malnutrition in infancy per se causes stunting of growth in children as it does in some animals. On the contrary, children who have been successfully treated for malnutrition tend to outgrow their siblings when they return home. It is suggested that this may have a genetic basis.

66. Glaser, H., Heagarty, M., Bullard, D. & Pirchik, E. Physical and psychological development of children with early failure to thrive. Journal of Pediatrics, 1968, 73, 690-708.

This study examined fifty children who were hospitalized with the failure-to-thrive syndrome. Failure to grow in size, to gain weight, or to develop motor skills were the major complaints presented by the parents of the fifty patients who came from all social strata. The children were pale, malnourished, showed loss of subcutaneous tissue and muscle mass, and were below normal in height and weight. The infants were lethargic and apathetic. The age range was 15 infants under 6 years, 13 from 7 to 12 years, 10 from 13 to 18 years and 12 over 18

years old. Upon discharge, children were returned to the care of their private physicians. A follow-up study revealed a substantial incidence of continued growth deficits, both in height and weight. Mental retardation, emotional disturbance, and family dysfunction were commonly found, although a minority of the children from adequate home environments appeared to have recovered spontaneously without detectable deficits.

67. Gordon, J.E. & Scrimshaw, N.S. Infectious disease in the malnourished. Medical Clinics of North America, 1970, 54(6).

Childhood diseases such as measles, whooping cough and chicken pox interact with malnutrition to cause more serious complications including kwashiorkor. Diarrhea is often present during these diseases, and contributes to a further weakening of the body's defense mechanisms. The synergistic relation of nutrition and infection is more pronounced during the periods of rapid growth: the first three months of life, and during the second year. In developing countries the synergism of malnutrition and infection can contribute to subsequent impaired learning and behavior. It was also noted that even in industralized countries food fads and unwise dieting can precipitate these same types of synergistic relations.

68. Graham, G.G. Effect of infantile malnutrition on growth. Federation Proceedings, 1967, 26(1), 139-143.

Longitudinal studies of 53 severely malnourished children show that an inadequate diet can have marked effects on subsequent growth, especially growth of the head. In general, the head circumference and height were significantly below the 50 percentile values even after resumption of proper diet.

69. Grotberg, E.H. Neurological aspects of learning disabilities: A case for the disadvantaged. Journal of Learning Disabilities, 1970, 3(6), 321-327.

While researchers tend to agree that learning disabilities include neurological factors, there is insufficient understanding of the relationship of these symptoms to different socio-economic groups, or to various nutrition components. The result is a neglect of low-income children who demonstrate the symptoms of learning disabilities but have symptoms confounding the diagnosis.

70. Gussow, J.D. Bodies, brains, and poverty: Poor children and the schools. New York: ERIC Clearinghouse on the Urban Disadvantaged, Columbia University, 1970. (ED 047 025, 20p.)

This issue of the IRCD Bulletin reviews the status of research relating to health, nutrition and learning pertaining to economically disadvantaged children. There is little conclusive evidence to support the notion that a child's present biological condition is correlated with his learning. The question thus remains as to whether it is rational (or humane) to attempt to teach a child who is hungry, ill, or tired. If not, then health and nutritional programs should be instituted as a necessary course of action. Also included in this issue of the Bulletin is an article on recommendations for child health care, which has been reprinted from the Bulletin of Pediatric Research, November 1970, Vol. 4.

71. Gutelius, M.F. The problem of iron-deficiency anemia in preschool Negro children. American Journal of Public Health, 1969, 59(2), 290-295.

Among 460 preschool Negro children from low income families, 29% were found to have low hemoglobin levels. Although these children had received well-child care, none had had a hemoglobin determination. The need to provide iron in dietary milk as a public health measure is emphasized.

72. Gyorgy, P. Editorial: The late effects of early nutrition. American Journal of Clinical Nutrition, 1960, 8, 344-345.

There is growing recognition that nutrition may be an environmental factor of overriding importance. Genetics has long been claimed to be the determining factor in growth and development; environmental factors, such as nutrition or infectious diseases, were credited with only transient effects. More recently, observations are accumulating both from experimental and clinical studies which may cast some doubt on the rigid division between lasting genetic and temporary nutritional effects. R.A. McCance's research with rats and comparisons of Japanese and Japanese-American growth and development are cited. The late effects of early nutrition is a field worthy of intensive exploration and should yield important new knowledge.

73. Gyorgy, P. Protein-calorie and vitamin malnutrition in Southeast Asia. Federation Proceedings, 1968, 27(3), 949-953.

The gap between the affluent few and the hungry millions is widening and may become unbridgeable if current efforts to effect change fail. In many parts of the world, especially in the rice-eating countries of Southeast Asia, up to 70-80% of the preschool children are undernourished

and have no opportunity to develop their full potential. With rice as the staple food of the population, the growing child receives insufficient amounts of protein and calories. In countries like Indonesia and also Thailand, especially in the northeast provinces, the diet is also poor in vitamin A. Data from these Indonesian studies indicate a very significant growth retardation in comparison to American normal values. Retardation may be as much as 5 months for a 9-month-old infant, and 4 years for a 12-year-old Indonesian child. This phenomenon is an impressive manifestation of metabolic adaptation. Recent anthropological studies from Japan indicate that the adaptive retardation in length-growth is not due so much to genetic as to environmental factors, especially nutrition.

74. Gyorgy, P. & Kline, O.L. Malnutrition is a problem of ecology. New York: S. Karger, 1970.

This book consists of papers presented at a conference on world-wide nutrition problems. The conference had a multi-disciplinary approach, suggesting that the problems of developing countries cannot be solved by narrow, isolated approaches. Discussion topics include socioeconomic factors, ecological factors, nutrition and technical assistance, the modification of attitudes and behavior, evaluation, and maternal health.

75. Harrell, R.F., Woodyard, E. & Gates, A.I. The effect of mothers' diets on the intelligence of offspring. New York: Columbia University Bureau of Publications, 1955.

The diet of pregnant and lactating women was supplemented with vitamins in an effort to study the effect upon the intelligence quotients

of their offspring. Results indicated that vitamin supplementation of pregnant and lactating women under certain circumstances does increase the intelligence of their offspring, at least for the first four years of their lives.

76. Hegsted, D.M. Deprivation syndrome or protein-caloric malnutrition. Nutrition Reviews, 1972, 30(30, 51-54.

Malnutrition in the infant and preschool child has a very complex etiology. An unsatisfactory physical environment and infection accentuate an already precarious nutritional state. Because of these factors, the child may be unable to learn (due to illness) at appropriate times in his development. Whether permanent mental disabilities are imposed by nutrition per se is problematical, but the net result is a child who is retarded in both physical and mental development. Remediation programs must include attention to all aspects of a child's development, not just the nutritional aspects.

77. Hunger, U.S.A.: A report by the citizen's board of inquiry into hunger and malnutrition in the United States. Boston: Beacon Press, 1968. (ED 036 566, 100p.)

The findings of the Citizen's Board of Inquiry are that: 1) hunger and malnutrition affect millions of Americans and are increasing in severity each year; 2) infant deaths, organic brain damage, retarded growth and learning rates, increased vulnerability to disease, withdrawal, apathy, alienation, frustration and violence appear to result from hunger and malnutrition; 3) Federal programs to alleviate the problem have by and large failed; and 4) the policies of the agricultural committees of Congress and the Department of Agriculture have discriminated against

the needs of the poor and hungry in the interest of the agricultural producers. Topics covered in the report are bureaucratic nonresponse in Mississippi, the extent of hunger and malnutrition, analysis of food and welfare programs (comprising commodity distribution programs, food stamp programs, consumer education programs, and public assistance programs), and agricultural policy. The report concludes with recommendations proposed by the Board of Inquiry.

78. Jelliffe, D.B. & Jelliffe, E.F.P. Nutrition programs for preschool children. The American Journal of Clinical Nutrition, 1972, 25(6), 595-605.

Malnutrition in early childhood is the world's dominant public health problem. It is estimated that there are 10-20 million young children with kwashiorkor or marasmus, and that most of those children die at an early age. Approximately 1/3 to 2/3 of the preschoolers in underdeveloped countries suffer from lesser degrees of malnutrition, and may therefore have impaired physical and mental development. It is suggested that comprehensive nutrition programs be implemented, which should include parent education programs. Programs should be adapted to the local cultural patterns, should have as much community participation as possible and should have supplementary feeding programs for young children.

79. Jervis, G.A. (Ed.) Expanding concepts in mental retardation. Springfield, Ill.: Charles C. Thomas, 1968.

The genetics of mental retardation are discussed in terms of geographical isolates, prospects for prevention of trisonic conditions,

population genetics, and cytogenetics of Down's syndrome. Deprivation factors in mental retardation include institutional factors, day care programs for the disadvantaged, effects of Head Start and outer-directness in problem solving. Memory formation in goldfish, the postnatal origin of microneurons, and the role of proteins in neuronal membrane functions are considered as biological bases of learning. Operant techniques in mental retardation involve research in academic education, short term memory and rote learning, instruction in an institution, and establishment of tone control and evaluation of the hearing of the severely retarded. The socioeconomics of mental retardation include institutionalization, adjustment, community approaches, and rehabilitation of the severely retarded. Included in the section on physical performances are physical performances of the trainably retarded, diagnosis and prescription recreation, the factor structure of motor abilities, and current status of research.

80. Johnson, N.E., & Found, R.E. Malnutrition: A deterrent to human progress. Journal of Extension. 1971, 9(4), 23-30.

The authors discuss the effects of malnutrition on retardation of mental development and intellectual capacity. Research findings on undernourished experimental animals are cited. Also included are studies involving children suffering from the effects of malnutrition in infancy.

81. Kallen, D.J. Nutrition and the community. In D.J. Kallen (Ed.) Nutrition, development, and social behavior, Washington, D.C.: U.S. Government Printing Office, in press.

Very often the social conditions associated with malnutrition tend to inhibit adequate intellectual development, independent of nutrition status. At the same time, the physiological changes, particularly the lack of responsiveness, lack of attention, and apathy which characterize the malnourished, may themselves interfere with adequate intellectual development through the blocking of external and internal stimuli. Little is known about the relationship of nutrition to social competence. However, similar mechanisms may exist for social functioning as for intelligence. If so, the lack of early learning due to lack of responsiveness will inhibit role development and adequate social development and tend to perpetuate within the society a group which remains in a disadvantaged position. For the child, hunger can be as de-energizing as severe malnutrition. If the child must spend his time worrying about having enough to eat, he will have neither the energy nor the attention necessary for learning. This condition, in turn, will create expectations about his abilities which will prompt differential treatment by his teachers and may lower his educational rank. When such a child becomes an adult he is unlikely to have the resources to prevent his own children from being hungry. Thus, the cycle perpetuates itself.

82. Kallen, D.J. Nutrition and society. The Journal of the American Medical Association, 1971, 215(1), 94-100.

Malnutrition during development leads to high infant mortality and smaller physical size. While severe malnutrition may lead to intellectual impairment, the direct relationship between moderate malnutrition and intelligence is still unknown. Because both nutrition and intellectual

development are associated with various social factors. The negative effect of moderate malnutrition may cause apathy in learning and maladaptation to other situations which relate to life success.

83. Kallen, D.J. (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

This book reports the proceedings of a conference on the Assessment of Tests of Behavior from Studies of Nutrition in the Western Hemisphere. Topics covered include theoretical and methodological issues, problems with field studies, discussions of cognitive and intellectual development, and discussions of social behavior and the role of nutrition.

84. King, L.S. Intrauterine malnutrition. Journal of the American Medical Association, 1965, 191(13), 1077.

A discussion of the effects of intrauterine malnutrition outlines the physical and mental subnormalities generally found.

85. Klein, R.E. Some considerations in the measurement of the effects of food supplements on intellectual development and social adequacy. Paper presented to the International Conference on Amino Acid Fortification of Protein Foods, Massachusetts Institute of Technology, September, 1969.

The author suggests that certain forms of malnutrition, especially protein-calorie malnutrition, may seriously restrict optimal intellectual development. However, many difficulties are encountered in studying this phenomenon. Mental and social development are multi-determined processes. In addition, any group selected for study must have an adequate control group. In selecting a population, the younger the child the better, since the central nervous system may be particularly

susceptible to the effects of malnutrition during the last trimester of pregnancy and first six months of life. The effects of malnutrition seem to vary inversely with the age of onset, and directly with its duration and severity. Assessment presents a problem since it is suggested that the investigator select tests which reflect both his framework for conceptualizing the effects of nutrition and his theoretical point of view on cognitive development. In addition, the tests must be valid for the population intended and culturally relevant.

86. Klein, R.E. & Adinolfi, A.A. Measurement of the behavioral correlates of malnutrition. Paper presented at the Conference on Neuropsychological Methods for the Assessment of Impaired Brain Functioning in the Malnourished Child, Palo Alto, June 1969. (INCAP Publication #548, Institute of Nutrition of Central American and Panama, C.A.) Also in J. Prescott, D.B. Coursin & M.S. Read, (Eds.) Malnutrition and brain function: Neurophysiological methods of assessment, Washington, D.C.: U.S. Government Printing Office, 1971.

The authors present a review of the literature covering three areas: methodology and measurement; studies of behavioral correlates of malnutrition; and theoretically guided assessments of cognitive and personality correlates of malnutrition. They suggest that although most of the studies have methodological problems further research should be continued in the area. Early malnutrition is associated with several consequences, including decrements in various measures of intellectual performance in children. It is necessary to consider the total individual with all his complex inner functionings and societal relationships in trying to determine the role malnutrition plays in the lives of those who suffer from it.

87. Klein, R.E., Habicht, J.P. & Yarbrough, C. Some methodological problems in field studies of nutrition and intelligence. In D.J. Kallen, (Ed.) Nutrition, development and social behavior, Washington, D.C.: Government Printing Office, in press.

The authors suggest that adequate measures must be found to use in the study of the effects of malnutrition. Nutrition must be quantified in some way, possibly using dietary surveys. Both the magnitude and significance of nutrition effects should be studied.

88. Klein, R.E., Habicht, J.P. & Yarbrough, C. Effect of protein calorie malnutrition on mental development. INCAP Publication I-571, Institute of Nutrition of Central America and Panama, Guatemala, C.A. (To be published in Volume 18 of Advances in Pediatrics)

Among the widespread nutritional diseases of childhood, only protein-calorie malnutrition has been implicated as a cause of permanent deficit in mental development. Two strategies used to study the impact of malnutrition upon mental development include the search for long lasting changes in learning and behavior and the demonstration of physical evidence of permanent damage to the central nervous system. Various studies in the area of malnutrition and mental development are reviewed and the confounding factors of test bias, social class, environment, time of onset, and duration are cited as important variables.

89. Klein, R.E. & Yarbrough, C. Some considerations in the interpretation of psychological data as they relate to the effects of malnutrition. Guatemala, C.A.: Institute of Nutrition of Central America and Panama (INCAP), Division of Human Development, undated.

Among the many confounding variables in studying the effects of malnutrition are social class and child rearing practices, hospitalization,

and medical factors such as intrauterine infection and perinatal anoxia. Another research complication is the appropriateness of the tests used, especially those which are written and normed in one culture and used in another. A third consideration is the appropriateness of the control group, since often social and environmental factors are also at work on those children who are malnourished.

90. Klein, R.E., et al. Performance of malnourished in comparison with adequately nourished children on selected cognitive tasks. Paper presented at the annual meeting of the American Association for the Advancement of Science, Boston, December 1969.

In this pair of studies conducted in Guatemala, a variety of tasks was employed. These included measures of memory, language development, perceptual ability, and tasks that measured motor control and task persistence. Malnourished subjects were found to perform more poorly than well nourished subjects on several measures of short-term memory as well as on two measures of perceptual ability. The pattern of differences between the well nourished and malnourished groups may reflect differences in attentional involvement in the tasks rather than differences in intellectual ability.

91. Kubala, A.L. & Katz, M.M. Nutritional factors in psychological test behavior. The Journal of Genetic Psychology, 1960, 96, 343-352.

This study investigated the effects of a dietary deficiency in citrus products upon mental test performance and evaluated changes in performance after a period of supplementation with orange juice. Subjects included students in grades K-9, who were tested and divided into two groups

according to presence or absence of deficiency in ascorbic acid. Both groups were given IQ tests prior to the supplementary program, with the deficient group having a significantly lower mean I.Q. After the supplementation program, both groups were tested again. Results indicated that the deficient group had a significantly larger gain than did the nondeficient group. The implications of these findings in light of the nature-nurture controversey are discussed.

92. Kugelmass, I.N., Poull, L.E. & Samuel, E.L. Nutritional improvement of child mentality. American Journal of Medical Science, 1944, 208, 631.

In this study investigators analyzed the effects of nutritional improvement on mental performance in children who were matched for chronological age and intelligence quotient (IQ) but who differed in nutritional status. Two matched groups each containing 50 children ranging in age from 2 to 9 years were selected. One was identified as intellectually normal and well-nourished, and the other as intellectually normal but malnourished. After a period from 1 to 3 1/2 years, during which time nutritional status was improved in the malnourished group, psychological testing was repeated. It was found that while the average IQ of the initially nourished group was markedly stable, the IQ of the initially malnourished group rose an average of 18 points following improvement in nutritional status.

93. Latham, M.C. International nutrition and later learning. In Nutrition and intellectual growth in children, Washington, D.C.: Association for Childhood Education International, 1969.

Reviewed are studies of animals and children which indicate the reduced intellectual functioning of malnourished children throughout

the world. One of the few long range studies reported comparative groups of 25 children each matched by age and intelligence, but with one group composed of malnourished children, and the other, well-nourished. The matched groups received nutritionally adequate diets. Later IQ tests showed the IQ of the malnourished children rising an average of 18 points and that of the well-nourished children showing no change. The implication is that because of dietary deficiencies the malnourished children had not reached their full potential and that correction of deficiencies resulted in a rise in IQ, while the well-nourished control group children showed no changes over the same period of time.

94. Latham, M.C. & Cobos, F. The effects of malnutrition on intellectual development and learning. American Journal of Public Health, 1971, 61(7), 1307-1324.

A strong association exists between malnutrition early in life and later intellectual development. The factors (biological, social, psychological) involved and how they act are considered in this review of recent research on the problem. A new hypothesis is offered to explain the role of malnutrition in retarded intellectual development.

95. Leverton, R. Facts and fallacies about nutrition and learning. Journal of Nutrition Education, 1969, 1, 7-9.

Two questions are discussed: 1) What are the key facts about the effect of nutrition on learning and behavior? and 2)What are the implications and challenges to the total school program? The effect of malnutrition on the development and functioning of the central nervous system depends on when the deprivation occurs, how long it

lasts, and how severe it is. Nutrition does influence the structure of the central nervous system. The most crucial period of influence is from 3 months before birth until 6 months after birth, and continuing at a reduced rate until the child is 3 years old. The school health service needs to be alert to the nutritional status of the children, to borderline malnutrition and suboptimal performance as well as to outright symptoms of malnutrition. Malnutrition may occur in middle and upper class homes due to poor supervision and poor eating habits.

96. Liang, P., Hie, T., Jan, O & Giok, L. Evaluation of mental development in relation to early malnutrition. American Journal of Clinical Nutrition, 1967, 20, 1290-1294.

The authors investigated the effects of malnutrition on mental development using Indonesian children as subjects. Their findings substantiated those of many others in other countries: early malnutrition does have a detrimental effect on mental development.

97. Malnutrition and physical and mental development. Nutrition Review, 1970, 28, 176-177.

Numerous studies have attempted to relate undernutrition during early life to later physical and mental development. Retrospective studies compare malnourished children with normal children. Such studies are able to use large numbers of subjects in a relatively short time but contain a peer definition of the nutritional state during the critical period being examined. Controls must also be selected on the basis of nutritional history and may in themselves have been inadequately nourished.

Perspective studies have fewer children but the children are evaluated nutritionally by the investigators. This method offers better nutritional information and selection of controls at the time the study population is defined. Both types of investigations suggest that undernutrition in early childhood may be associated with reduced height, cranial circumference, and motor and sensory development. Data suggest that in infants malnourished before six months of age, impairment was most marked and recovery least likely.

98. Malnutrition in the United States. Dairy Council Digest, 41(2).

Comparison of family food consumption data in 1965 versus 1955 indicated that the nutritional value of diets has been declining rather than improving in the last 10 or 15 years. Two recent analyses of studies (which were not necessarily representative) found that a higher incidence of malnutrition occurred in lower-income groups, less well-educated groups, and in certain minority groups such as Negroes, Puerto Ricans, and Indians. Kelsay noted a high incidence of anemia in preschool children and pregnant women with a higher incidence in Negro children than in Caucasians of the same socioeconomic level. Also, in most studies of ethnic diets, it appeared that Negroes were less well-nourished than Caucasians. However, studies in some areas showed that Negroes had a higher intake of certain nutrients than Caucasians. Such observations illustrate the point that generalizations about nutritional status can not be applied either to an individual or a group of persons without further testing.

99. McKay, H. & McKay, A. Behavioral intervention studies with malnourished children: A review of experiences. Paper presented at Western Hemisphere Conference on Malnutrition and Mental Development, Mayaguez, Puerto Rico, 1970.

The reversibility of the poor performance noted on measures of cognitive development for malnourished children was studied by the authors. They used discrete measures of verbal and nonverbal performance on an experimental intervention which involved several months of intense cognitive stimulation, nutritional rehabilitation, and health care. Interpretation of results is complicated by the large number of experimental and control subgroups. Overall, however, nutritionally normal children performed better than malnourished children both before and after cognitive stimulation, even though the treated malnourished children achieved a level of performance similar to normally nourished unstimulated children.

100. McKay, H. E., McKay, A.C. & Sinisterra, L. Behavioral effects of nutritional recuperation and programmed stimulation of moderately malnourished preschool age children. Paper presented at the annual meeting of the American Association for the Advancement of Science, Boston, December 1969.

In the study evaluating the effects of cognitive stimulation, nutrition and health care on test performance, six intelligence-type tests were used: three involving verbal responses (Memory for Sentences, Sentence Completion, and Picture Vocabulary Test) and three performance tests not requiring verbal responses (Knox Cubes Memory for Patterns, a motor control test called Draw A Line Slowly, and a Visual-Haptic Cross-Modal Matching task). Also included in the test battery were achievement tests of the children's ability to work with numbers and letters. Children who received both

cognitive stimulation and nutritional treatment improved significantly on the achievement tests, both in comparison to the group receiving only nutritional treatment and the no-treatment control group. Nutritional treatment alone produced no improvement over the no-treatment control group.

101. McKay, H.E., McKay, A. & Sinisterra, L. Behavioral intervention studies with malnourished children: A review of experiences. In D.S. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

A three year research program concerned with the effects of multiple deprivations on the health and behavior of children was conducted in Cali, Colombia. Special emphasis was given to the effect of malnutrition on the behavioral development of preschool children from the lowest economic levels of that city. It was concluded that capabilities are retarded early in the lives of children who have chronic malnutrition and other health deficits. Carefully designed experiments show that some retarded developmental characteristics are remediable through treatment beginning in the preschool years. However, questions raised by the study include the following: 1) what aspects of development are affected by deficiencies and to what degree are they differentially affected; 2) what is the relevance of development to the future functioning of children in school and society; 3) what is remediable in the preschool years; 4) what combinations of nutrition, health and behavioral treatment are needed to modify effects; and 5) what is the age and length of treatment for maximum remediation.

102. McLaren, D.S., Kanawati, A.A. & Yatkin, U. The effect of stimulation on the recovery of malnourished infants. Paper presented at the symposium on Malnutrition and Behavior Disorders, at the Fifth World Congress of Psychiatry, Dec. 1971, Mexico City.

Twenty-six Lebanese children who had suffered from acute and severe protein-calorie malnutrition were divided into two groups. One group received stimulation during nutritional rehabilitation while the other did not. A markedly greater improvement in the DQ of the stimulated group was found, but was only of temporary duration. The possible influence of a number of home environmental factors was investigated. In general, the stimulated group had poorer living conditions. The importance of a prolonged period of adequate nutritional rehabilitation is emphasized.

103. Mental development following kwashiorkor. Nutrition Review, 1969, 27(2), 46-49.

There has been a reduction in mortality from kwashiorkor and nutritional marasmus in many countries due to better treatment and a realization by the population that these diseases can be cured. The most important studies to date on the effects of protein-calorie malnutrition in children on subsequent mental development have come from Africa, Latin America, and India. An assessment of mental development is difficult in these areas because instruments used to measure mental functioning in one culture may not be applicable to a different culture. A word of caution is necessary when drawing conclusions as there may be independent variables which act to produce both malnutrition and low intelligence, such as the hospitalization period of the experimental children, motivation of the parents, parental care and infectious diseases. High priority should be given to studies which separate the nutritional variables from genetic factors and environmental variables.

104. Mental development following nutritional marasmus. Nutrition Reviews, 1968, 26(4), 111-113.

The relationship between protein-calorie malnutrition in early life and subsequent retardation in mental development is well established, although not as a causal relationship, since malnutrition seldom occurs in isolation. However, in studying these conditions, several variables should be considered, including: 1) the conditions and duration of hospitalization; 2) the age of the child at the onset of malnutrition; 3) the social, economic, and family ecology from which the child comes; the educational level and intelligence of parents; and 5) the type of malnutrition present.

105. Mickelson, O., et al. The prevalence of anemia in Head Start children. Nutrition Evaluation, Merrill-Palmer Institute, Detroit. 1969. (ED 041 620, 22p.)

Concern over nutritional status of the disadvantaged children in America led to this study describing the prevalence of anemia among Head Start children in Pontiac, Michigan. Hemoglobin and hemacrit determinations, along with measurements of height and weight were performed on 77 children, 4 to 6 years old, enrolled in Head Start classes. These measurements were taken twice, at the beginning and end of a 6-month interval. Due to attrition during the interval, only 52 of the children were available for the second session. When compared to the standards commonly used in nutritional surveys, only one child on both occasions had a hemoglobin level that would be considered anemic (i.e., below 11 gm/100ml). The mehatocrit standard of anemia, however (less than 33%), indicated that 5.3% of the children were anemic at the first reading and 7.8% at the second. Eighty percent of the subjects at both readings were black, and

although the differences were not statistically significant, these children had lower hemoglobin and hemacrit values than their white classmates. Applying standards of height for age, the Stuart Meredith percentile standards and the Iowa growth charts, it appears that the Head Start children measured were well within the acceptable ranges of "norms."

106. Monckeberg, F.E. Effect of early marasmic malnutrition on subsequent physical and psychological development. In N.S. Scrimshaw & J.E. Gordon (Eds.) Malnutrition, learning and behavior. Cambridge, Mass.: MIT Press, 1968, Pp. 269-278.

The article reports a study of 14 malnourished Chilean infants who were hospitalized, treated, and then followed for several years. Results of physical and psychological tests led to the conclusion that brain damage in infancy is permanent at least up to the sixth year of life, despite improving nutritional conditions. The average intelligence quotient of this group was significantly less than the average of Chilean preschool children of low socioeconomic status.

107. Monckeberg, F.E. The effect of malnutrition and environment on mental development. Proceedings of the Western Hemisphere Nutrition Congress, II-1968, Chicago: American Medical Association, 1969, Pp. 216-221.

Three groups of preschool children were studied: a middle class, well-nourished group, a lower-class group participating in a nutritional supplementation program, and a group of lower class children who were malnourished. The last group performed significantly poorer on tests of intellectual ability even though their environment was similar to that of the second group. The first two groups performed essentially alike, despite their environmental differences. In this study, poor

nutrition appeared to be associated with poor test performance. Studying an impoverished area more closely, the author examined 150 preschool children and their mothers. He found poor intellectual performance to be highly associated with smaller head size and low protein diets of the children. After evaluating the mothers' intellectual abilities, he could also relate the low maternal performance with the children's poor nutritional conditions and poor intellectual performance. Thus, the interrelation between inheritance, social deprivation, and intellectual ability remains undetermined.

108. Monckeberg, F.E. Malnutrition and mental capacity. Paper presented at the seminar on Malnutrition and Early Life and Subsequent Mental Development, Pan American Health Organization, Kingston, Jamaica, Jan. 10, 1972.

Research has shown that in low SES groups with poor cultural and nutritive conditions mental and motor retardation can frequently be observed. It is not entirely clear just what the role of malnutrition is, since many cultural factors act negatively on mental performance and behavior. Whatever the cause, the low mental performance of members of these SES groups makes it difficult for them to become useful individuals in society. In Latin America, 20 of every 100 children who start school finish it. Children who leave school early are those who have the greatest intellectual and physical deficits. An adequate feeding program provided during the school years did not succeed in improving intellectual performance and learning capacities continued to be below normal.

109. Monckeberg, F.E. Malnutrition and mental behavior. Nutrition Review, 1969, 27, 191-193.

There seems to be strong evidence that malnutrition per se affects not only the expression of genetic potential in physical development, but also intellectual development as well. It is true that in underdeveloped countries, undernutrition is still the principal cause of premature deaths; but in the survivors the damage is still worse, producing limitations that make it difficult for them to be wholly incorporated into the socioeconomic development of the country.

110. Monckeberg, F.E. Nutrition and behavior: Practical problems in field studies in an urban community. In D.J. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

Poverty and malnutrition appear to interfere with the individual's physical and psychological development, as well as his integration into society. In studying the problem, both the magnitude and reversibility of malnutrition must be determined. Results of studies from the slum areas of Santiago, Chile suggest that environmental factors interact with malnutrition. In addition, a significant correlation ($r=.71$, $P<.001$) was found between mother's IQ and nutrition of the child. Although malnutrition and other social factors may produce low intellectual performance, mental deficiency may aggravate the situation.

111. Monckeberg, F.E. Nutrition and mental development. Nutrition Reviews, 1969, 27, 191-193.

Malnutrition is never an isolated problem yet it is almost impossible to analyze separately the various factors involved. Five hundred pre-schoolers in Santiago, Chile were studied to try to determine the effects of malnutrition on mental capacity during the preschool years. Groups studied

included nourished middle class children, nourished lower class children, and malnourished lower class children. In the first two groups 3% of the children had IQ's under 80, while in the third group 40% of the children had IQ's under 80. Results suggest that malnutrition per se probably was only one cause of lower mental capacity; others were environment and maternal motivation.

112. Moore, W.M., Silverberg, M.M. & Read, M.S. (Eds.) Nutrition, growth and development of North American Indian Children. Washington, D.C.: U.S. Government Printing Office, 1972.

This book presents an overview of the developmental problems of North American Indian children. Discussed are the diet, growth, and nutritional status of North American Indians, the developmental consequences of malnutrition, field studies of malnutrition and child development, cultural stability and social change in North American Indians, and nutrition research and community service among native American populations. (Chapters from the book are abstracted elsewhere in this bibliography.)

113. Munro, N. The relationship between hemoglobin level and intellectual function. Montana University: Missoula Foundation, 1967. (ED 028 830, 22p.)

One hundred thirteen children in a Head Start program in Missoula, Montana took part in a study to learn whether or not poor nutrition as indicated by low hemoglobin levels affects intelligence and behavior. Group testing with the Lorge Thorndike Intelligence Test and individual testing with the Wechsler and the Primary Scale of Intelligence for Children provided IQ information. An experimental group of Head Start children was given iron tablets daily at school, and a control group was given

placebos. Blood tests were taken at intervals during the school year, and teachers rated behavior for all the children. Results indicated that the iron pills did not significantly affect the hemoglobin levels. However, for those with low hemoglobin levels, increases in the levels were associated with increases in intelligence test scores.

114. Naeye, R.L. Undernutrition, growth, and development. New England Journal of Medicine, 1970, 282(17), 975-976.

Malnutrition in infancy is apparently related to mental and physical retardation. The age at which malnutrition occurs is important since the brain is more sensitive to nutritional deficiency at the time of the most rapid cell division. Diet therapy started before the age of four months was more effective than treatment begun between four and twelve months.

115. National Institute of Child Health and Human Development. Perspectives on human deprivation. Washington, D.C.: U.S. Government Printing Office, 1968.

This book is a state-of-the-art assessment of psychosocial deprivation. Four broad areas are covered: psychosocial deprivation and personality development; the influence of biological, psychological, and social deprivation upon learning and performance; socialization and social structure; and biological substrates of development and behavior. A fifth section, "Towards a research policy for psychosocial deprivation," was based on a two-day conference on these problems.

116. North, A.F. Nutrition of poor children. Project Head Start, Office of Economic Opportunity, Washington, D.C., 1968. (PS 001 802, 14p.)

While it has been well documented that many poor children in our country are hungry, the impact of hunger on measurable nutritional status, or on the actual physical, intellectual, social, and emotional function of children is largely unknown. Project Head Start has helped arouse the nation to the pressing need for social action and for basic knowledge, and has begun to provide some of that knowledge. More research is needed on the importance of various feeding and nutrition education programs, including those provided by Head Start.

117. North, A. Research issues in the health and nutrition in early childhood. Washington, D.C.: Office of Economic Opportunity, 1968. (ED 027 970, 31p.)

Ill health and its causes, such as poor nutrition, can keep a child from fully exploiting his environment. Important issues to be considered are as follows: 1) functionally important health problems frequently found in children; 2) techniques which identify the children who have problems; 3) treatment most effective to remedy the problems; and 4) resources (financial, manpower, administrative, organizational) to identify, remedy, and prevent the problems. Gaps in basic data governing these issues indicate the need for decisions concerning the content and organization of health programs. Diverse systems should be self-critical with built-in evaluation and monitoring to insure definite knowledge about the effectiveness of their treatment technique and organizational plans.

118. Nutrition and mental development. Dairy Council Digest, 1966, 37(5).

By the time a child is one year old, the brain is about 70% the size of that of an adult; by the age of four, brain growth is almost complete. During the first years of life, timing of the acquisition of each new specific brain function and the integration of the process into the total pattern of performance are of critical importance. Thus, if there is a disruption of this normal sequence, the individual may have limited capacity for certain abilities. Dobbing's study reported that malnutrition interfered with chemical development of the myelin sheath formation in pigs and rats. These animals never caught up with their litter mates in brain size or chemical maturation. A direct association has been reported between deficits in height and weight of malnourished children and retardation in language, adaptive, personal-social, and psychomotor behavior. Results of animal experiments lend support to the hypothesis that the greatest effect of malnutrition on ultimate size and performance of the mature individual is produced during the period of maximum growth. There is a great possibility that at least the children severely malnourished during the first six months of their lives might retain a permanent mental deficiency. Data from one study cited showed unacceptable forms of growth (with nutritional implications) were characteristically accompanied by academic underachievement which grew worse as the years of poor growth continued to accumulate.

119. Osofsky, H. Antenatal malnutrition: Its relationship to subsequent infant and child development. American Journal of Obstetrics and Gynecology, 1969, 105(7), 1150-1159.

The effects of nutritional improvement were studied in 91 malnourished children (CA 2-9 years). Forty-one were initially retarded; 50 were normal. The children were followed and retested after varying lengths of time (8 months to 7 years). It was found that the average IQ increased 10 points in the retarded group, and 18 points in the normal group. The author suggests that malnutrition affects intellectual development, and is apparently irreversible in the age group studied. A follow-up of 20 malnourished infants 11 years later, who had IQ's 20 points below their controls, showed that they had difficulty in visual-motor ability and pattern perception, and in many ways resembled brain damaged children.

120. Owen, G.M. et al. Nutritional status of Mississippi preschool children: A pilot study. American Journal of Nutrition, 1969, 22, 1444-1457.

This article reports a nutrition study involving 585 preschool children undertaken in cooperation with the Mississippi State Board of Health and the University of Mississippi Medical Center. There seemed to be a relationship between poverty, diet, and growth achievement.

121. Perspectives on human deprivation: biological, psychological, and social. Bethesda, Md.: National Institute of Child Health and Human Development, 1968. (ED 032 687, 329p.)

Aspects of deprivation treated include psychosocial deprivation and personality development; influences of biological, psychological, and social deprivation upon learning and performance; socialization and the social structure; and biological substrates of development and behavior. For each aspect, research is reviewed and suggestions are made for future research.

122. Phenylketonuria, a comprehensive bibliography, 1964. Washington, D.C., Children's Bureau, Report #CB-430, 1966. Available from the Superintendent of Documents, Washington, 35¢.

Intended as an aid to professional and technical persons interested in phenylketonuria (PKU), this bibliography lists and annotates 817 items. Content divisions are 1) general monographs and articles; 2) biochemistry--metabolism, experiments, tests, and cases in which the emphasis is on biochemistry; 3) genetics, gene studies, hereditary factors, and family trees; 4) case histories--single cases of small groups; 5) mental retardation--psychological, neurological, and behavioral aspects, and also brain pathology; 6) physical pathology--arrested development, motor disability, spasms, and electroencephalography; 7) dietary treatment--chemical components, synthetic foods, food stuffs and food supplements, and also menus; and 8) surveys and screening--procedures, projects, and incidence of PKU. An author index and a listing of journal abbreviations are included. Foreign language articles are noted.

123. Pollitt, E. Behavioral correlates of severe malnutrition in man. In W.M. Moore, M.M. Silverberg & M.S. Read (Eds.) Nutrition, growth, and development of North American Indian children, Washington, D.C.: U.S. Government Printing Office, 1972.

Human and animal data suggest that the younger the organism when malnourished the greater the possibilities that protein-calorie deficiency will adversely affect the growth and maturation of the brain. However, if the onset of the nutritional deficit occurs at about one year of age, other factors should also be taken into consideration in interpreting the differences between children with marasmus and kwashiorkor. Marasmus is more likely to result from biosocial factors, and does not have a distinct beginning. Kwashiorkor is more likely to have a single dietary

source. Research suggests that the length of the nutritional deficiency is an important variable in the intellectual recovery. In addition, the learning ability of a severely malnourished child is likely to be seriously affected. However, no evidence indicates that learning deficiencies are caused solely by nutritional deficiencies; it appears that the impairment is the result of an overall state of biological and psychological deprivation.

124. Pollitt, E. Behavioral correlates of severe malnutrition in man: Methodological considerations and selective review. In W.M. Moore, H.D. Riley & M.S. Read, (Eds.) Nutrition, growth and development of Native American children. Washington, D.C.: U.S. Government Printing Office, 1970.

A critical review of 8 investigations made in underdeveloped countries and completed between 1963 and 1969 is presented in this article. Overall, study results suggested that kwashiorkor was not necessarily associated with permanent intellectual damage, at least if the child was older than 12 months when the condition began. The authors concluded that a child who suffers from kwashiorkor after otherwise healthy early development seems to have a fair chance of recovering his full intellectual potential. Children suffering from nutritional marasmus, on the other hand, were more likely to have intellectual damage, probably because the brain grows faster during the early months of life when marasmus strikes.

125. Pollitt, E. Ecology, malnutrition and mental development. Psychosomatic Medicine, 1969, 31(3), 193-200.

The author critically reviewed eight investigations made in underdeveloped countries between 1963 and 1969 in which the children hospitalized with severe protein calorie malnutrition were observed after recovery.

Overall, the results suggested that kwashiorkor was not necessarily associated with permanent intellectual damage, at least if the child was older than twelve months when the condition began. He concluded that a child who suffers from kwashiorkor after an otherwise healthy early development seems to have a fair chance of recovering his full intellectual potential. Children suffering from nutritional marasmus were found to be more likely to have intellectual damage, probably because the brain grows faster during the early months of life when marasmus strikes. Marasmus might develop gradually from birth, increasingly debilitate the infant and limit his responsiveness to his surroundings, especially his mother. As the child's responsiveness decreases, the mother may become disheartened and transfer her attention to other healthier children in the family. Thus the marasmic child seems more likely to be permanently impaired because of his longer exposure to poor diet and multiple adverse environmental factors.

126. Pollitt, E. Poverty, malnutrition: Cumulative effect on mental development. Assignment: Children. 1971, 14, 40-55.

This paper indicated that children living in poverty are exposed to social and biological environmental factors likely to hinder cognitive development as well as from the nutritional deficiency per se. On the basis of the information presented, any program aimed at the rehabilitation or prevention of intellectual deficits of the malnourished child should not only consider the nutritional aspects but also the overall medical and social conditions.

127. Pollitt, E. & Granoff, D. Mental and motor development of Peruvian children treated for severe malnutrition. Revista Interamericana de Psicologia, 1967, 1(2), 93-102.

Twenty-seven children from the slums of Lima, Peru, hospitalized and treated for severe protein-calorie malnutrition were given the Bayley Infant Scale of Mental Development and the Bayley Infant Scale of Motor Development. The children ranged in age from 11 to 32 months with a mean age of 19.5 months. Only two of the children obtained scores above the basal levels of the scales, thus indicating severe mental and motor retardation despite their apparent somatic recovery from starvation. Degree of motor improvement was related to the duration of the hospitalization. Eight sibling controls from the slums scored within the normal range for their age, according to the American standardized scales.

128. Pollitt, E. & Ricciuti, H. Biological and social correlates of stature among children in the slums of Lima, Peru. American Journal of Orthopsychiatry, 1969, 39(5), 735-747.

A study of a sample of children with contrasting stature from the slums of Lima, Peru showed that the short children were more likely to have shorter mothers who had had more pregnancies, less years of schooling, and a greater number of marriages. Although differences in stature might reflect differences in nutritional background, they are also likely to reflect differences in other important biosocial factors. Studies relating nutritional status (undernutrition) to psychological development are discussed.

129. Preschool child malnutrition. Washington, D.C.: National Academy of Science, National Research Council, Publication #1282, ($7.50)

This book reports the proceedings of an international conference on the prevention of malnutrition in preschool children. Topics covered include the effects of malnutrition on physical and behavioral development, results of specific nutritional deficiencies, programs for combatting

malnutrition in various countries, experiences in the development of food products for the preschool child, social and educational problems associated with malnutrition in the preschool child, and approaches to alleviation measures. Malnutrition in the preschool child is one of the world's most serious health problems. As many as 70% of the children in developing countries may be malnourished, presenting a great impediment to physical, mental, and economic growth. Malnutrition is a serious deterrent to progress in developing countries since it weakens the productive capacities of surviving adults.

130. Prognosis for malnourished infants. Nutritional Review, 1967, 25(11), 332-333.

Mortality among a large number of severely malnourished children was increased when, on admission to the hospital, the body weight deficit (compared with standard height and age tables) was large, dehydration was severe, the liver was enlarged, and the serum bilirubin level was increased. Among 100 children admitted to the hospital during the winter of 1957, 20% died despite administration of skim milk and, when necessary, saline solutions. There was no difference in age distribution among the children who died and those who survived. Most of the infants who died were 50% or more below the average weight for their age, while a similar degree of undernutrition was seen in 30% of the survivors.

131. Rajalakshmi, R. The psychological status of underprivileged children reared at home and in an orphanage in South India. Indian Journal of Mental Retardation, 1968, 1(2), 53.

Children living in an orphanage in South India and children living in their own homes in a small village near the orphanage were tested for psychological performance. The results showed that nutritional improvement alone does not restore psychological functioning in children whose social and cultural environment is totally lacking in emotional and psychological stimulation.

132. Read, M.S. The biological bases: Malnutrition and behavioral development. In Seventy-first yearbook of the National Society for the Study of Education, Early childhood education. Chicago: University of Chicago Press, 1972, Pp. 55-69.

Severe malnutrition during the fetal period and infancy in animals and humans decreases brain size, reduces the number of brain cells, and results in behavioral abnormalities. The relationship between lesser degrees of malnutrition and intellectual development is not clear. Social, genetic, and other factors assume greater roles under the latter conditions. Before any definite conclusion can be drawn that malnutrition per se is a cause of mental subnormality, carefully designed longitudinal studies must clarify the role of parental interaction with the malnourished child and provide an understanding of the social-environmental factors which accompany malnutrition. Special attention should be given to the social-psychological and the nutritional consequences of recurrent infections. Preventive programs should be concerned with the improvement of all facets of the environment, including control of infection, training mothers in infant care, improvement in food use, and the betterment of the socioeconomic conditions which underlie this worldwide problem.

133. Read, M.S. Malnutrition and learning. American Education, 1969 5(10), 11-14.

The author defines malnutrition as a state in which an individual lacks one or more nutrients to the extent that specific symptoms and conditions appear, such as anemia, goiter, rickets, vitamin deficiencies, or retardation in physical development. Undernourished or hungry children frequently exhibit behavioral alterations, including apathy, lethargy, inability to pay attention and perhaps overconcern about food to such a degree that responses to classroom stimuli do not occur. A child in such a condition no longer meets the expectations of his family or teachers. He begins to live in a world of his own and may seek recognition or gain attention in ways that disrupt learning experiences. Parents and teachers may react to his social behavior and withdraw some of the stimulation necessary for adequate mental development.

134. Read, M.S. Nutrition and ecology: Crossroads for research. In P. Gyorgy and O.L. Kline (Eds.) Malnutrition is a problem of ecology. New York: S. Karger, 1970, Pp. 202-217.

Nutrition is important from conception until death. Research on malnutrition and development has shown the effects to be cyclical and related to other kinds of deprivation. Early deficiencies cause later effects which set the stage for new deprivations. Survival of each species depends upon its ability to adapt to a changing environment and to utilize available food stuffs to meet minimal needs. Since man can control his environment more than any other species, he must learn the importance of nutrition as an influence in many areas of human development.

135. Rendon, R. et al. The effect of malnutrition on the physical and mental development of children. In G. Farrell (Ed.) Congenital mental retardation. Austin, Texas: University of Texas Press, 1969, Pp. 262-288.

A comparison of 18 malnourished hospitalized children (CA less than one year) with 18 controls revealed that malnourished children evidenced noticeable deficiencies in anthropometric measurements, development, and functioning levels. Deficiencies in all areas of infant mental development and especially in the development of language and social-personal attitude persisted even after nutritional recovery was satisfactory. All malnourished children came from bad to very bad socioeconomic situations and broken homes. Many of their parents functioned at a below average intelligence level. The deficiencies of the malnourished group cannot be attributed solely to reduced protein and calorie intake because of multiple interrelated factors, such as the lack of environmental stimulation, extreme poverty, poor parent education, and parental intelligence.

136. Ricciuti, H.N. Malnutrition in infants. In D.J. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

This paper focuses on a discussion of two interrelated issues in research on infant malnutrition and psychological development. Primary interest is centered on the problem of specifying and assessing the most functionally relevant (behavioral, learning, and psychological) forms of malnutrition in the infant. Some consideration is also given to the related problem of isolating the influence of malnutrition per se from that of related social, environmental, and biological factors, and as determining the manner in which these factors interact with malnutrition in jointly affecting psychological development.

137. Ricciuti, H.N. Malnutrition, learning, and intellectual development: Research and remediation. Paper presented at the American Psychological Association, Sept. 1969. Also in Psychology and the problems of society, Washington, D.C.: American Psychological Association, 1970. (ED 039 017, 33p.)

Increased interest in the effects of malnutrition has been evidenced since World War II, and especially during the last decade during the "War on Poverty". After presenting a summary of some of the available literature, the author concludes that one can usually relate mental retardation and malnutrition in children hospitalized for malnutrition. It is more difficult to attribute causes in less severe cases, especially in disadvantaged populations where there are confounding factors. Most of the studies included in this summary had been carried out in other countries, mostly Latin America, Africa, and Asia.

138. Rosso, P., Hormazabal, J. & Winick, M. Changes in brain weight cholesterol, phospholipid, and DNA content in marasmic children. The American Journal of Clinical Nutrition, 1970, 23(10), 1275-1279.

Wet weight, dry weight, cholesterol, phospholipid, and DNA content were all reduced in the brains of nine children who died of severe undernutrition. The reductions were proportional during the first year of life. By contrast, DNA was reduced less than the other parameters during the second year of life. Data interpretation indicates a reduction in the number of cells, each containing a normal amount of protein and lipids, during the first year. During the second year, the size of the remaining cells is reduced. This reduced size is a consequence of both reduced protein content and reduced lipid content per cell. The proportional reduction of protein and lipid suggests the possibility that the reduced cell size may be accompanied by a reduction in the size of the cell processes.

139. Sandstead, H.H., Freeman, H.B. & Zanderzwaag, R. Nutritional deficiencies in disadvantaged preschool children: Their relationship to mental development. American Journal of Diseases of Children, 1971, 121(6), 455-463.

The nutritional status of 100 preschool children from the economically depressed area of Nashville was evaluated and correlated with Stanford-Binet scores. Findings included mild growth retardation, nonspecific physical abnormalities, and goiter (the latter in 8.7% of the children). Laboratory studies revealed decreased body stores of vitamin A (96%), iron (35%), folic acid (17%), and thiamine (13%) in a high proportion of the children. Results of hospital oriented biochemical screeening tests were normal. Significant correlations were found between initial intelligence score, final IQ, and IQ differences following language education, all of which related inversely to age. Biochemical indices and IQ did not correlate. Anthropometric measurements revealed correlations between height and serum vitamin A and iron, and an inverse correlation between head:chest ratio and erythrocyte transkeolase activity. Relevant ecological factors included a marginal family income, a lack of parental understanding of nutrition, and a lack of parental supervision, particularly at mealtime.

140. Schlenker, J.D., Bossio, V. & Romero, E.D. Social development of preschool children with kwashiorkor and marasmus. Archives of Latin American Medicine, 1968, 18, 175.

For the purpose of this study, undernourished children with marasmus are defined as those with body weight less than 60% of the weight of normal children of the same age, without clinical edema or depigmentation of hair or skin. Children with kwashiorkor must represent clinical edema, depigmentation of the skin or hair, hepatomegaly, and weight, taken

with edema, greater than 60% of the weight for their age. The children were taken from two hospitals in Bogota, Colombia. Only those undernourished children who did not have a chronic infection were included in the study. Those found to have a mental deficiency which was congenital or caused by trauma or infection were also excluded. The chronological age, weight, height, and social maturity of each child was measured. Forty-four children with kwashiorkor and 27 with marasmus from the total sample were able to be studied for their social development. The Vineland Scale of Social Development was used. The investigation showed that the children with marasmus have a height significantly less than those with kwashiorkor, which suggests that marasmus is more chronic. The marasmic children have a social development inferior to those with kwashiorkor. The syndrome marasmus has a deleterious effect not only on physical development, but also on social maturity.

141. Scrimshaw, N.S. Early malnutrition and central nervous system function. Merrill Palmer Quarterly, 1969, 15(4), 375-388.

Children with a history of early and prolonged malnutrition do less well on most intelligence and behavioral tests. Malnutrition is often compounded by social and psychological factors as well. Malnutrition is a major factor in the high morbidity and mortality rates of infants and preschool children in developing countries. It not only results in nutritional diseases such as marasmus and kwashiorkor, but it is also responsible for lower resistance to infectious diseases. The social factors responsible are difficult to correct within a single generation, but programs of preventive medicine, applied nutrition, and public health can help underpriviledged children.

142. Scrimshaw, N.S. Infant malnutrition and adult learning. Saturday Review, 1968 , 51(11), 64-66, 84.

A review of studies of malnutrition (especially in underdeveloped countries) indicated that growth retardations characteristically begin after the first four to six months of life and become progressively worse until the child passes the critical weaning period or succumbs to kwashiorkor or an infectious disease. Poor growth is associated with the inadequacy of breast milk as a sole source of protein after a child is six months old. One result is a high mortality rate for children from these countries. Psychological and social deprivation is also common among malnourished children, and can exert a direct influence on intellectual performance. Malnutrition can apparently interact with heredity, infection, social and environmental factors to bring about physical and mental impairment.

143. Scrimshaw, N.S. Malnutrition, learning and behavior. American Journal of Clinical Nutrition, 1967, 20(5), 493-502.

In a review of the literature on malnutrition, the author suggests that available evidence indicates that malnutrition during the first few years of life does have an adverse effect upon subsequent learning and behavior. The mechanisms involved are not yet well established, and clarification of the precise timing, nature, and severity of malnutrition is needed. Nevertheless, it is evident that the effects of malnutrition of young children cannot be neglected.

144. Scrimshaw, N.S., Taylor, C.E. & Gordon, J.E. Interactions of nutrition and infection. WHO Monograph Series, No. 57, 1968.

This discussion of the synergism of malnutrition and infection argues that the simultaneous presence of malnutriton and infection usually results in an interaction that is more serious for the host than would be

expected from the combined effect of the two working independently. In great detail the book reviews evidence to support the hypotheses that infection has an adverse effect on nutritional status and that malnutrition, in turn, lowers resistance to infection. The synergistic relationship among weaning, diarrhea, and malnutrition is considered in detail.

145. Simonson, M. & Chow, B.F. Maternal diet, growth, and behavior. In Nutrition and intellectual growth. Washington, D.C.: Association for Childhood Education International, 1969, Pp. 39-42.

Studies carried out on animals demonstrated that delays in development changes maze learning ability, and modification of normal activity and exploratory patterns were due to fetal and neonatal malnourishment consequent upon maternal malnutrition. It is possible that wide differences observed in human intelligence may, in part, be attributable to maternal deprivation.

146. Sinisterra, L. Nutrition and early mental development. Journal of Educational Research, 1970, 64, Inside cover.

During the past decade research has suggested a relationship between nutrition and mental and behavioral development. About two-thirds of the inhabitants of the world suffer from chronic malnutrition. When all forms are considered, undernutrition is a positive threat to four-fifths of the people of the world. The impact of malnutrition on mental development is most critical from conception to age six, since it is during this period that the brain achieves 90% of its growth. Undernourishment during these early years cannot be corrected after the child reaches school age. Thus, efforts by schools come too late to prevent

permanent mental damage. Often, along with poor diet, comes a dull psychological and social environment. The physically underdeveloped child is also a victim of environmental circumstance. Educators, health officials, and doctors must assist the family, particularly the mother, who has the major responsibility for raising children. Through teaching and practical demonstration the school could provide mothers and the community the knowledge needed to provide proper nutrition as well as emotional and psychological stimulation to preschool children.

147. Soewondo, S., Abednego, B., Pekerti, A. & Karjad, D. The effect of nutritional status on some aspects of intelligence. Paediatica Indonesia, 1971, 11, 28-36.

Indonesian children 6-15 years old were tested psychologically and nutritionally. Results show that undernutrition influences verbal abilities and abstraction, attention and concentration, and will decrease the mental effectiveness of the children. In studying the effects of malnutrition, environmental effects should not be ignored. For intelligence to function at an optimum, any improvement of nutritional status should be accompanied by improvements in socioeconomic, psychological, and educational conditions.

148. Springer, N.S. Nutrition and mental retardation: 1964-1970. Ann Arbor: University of Michigan, Institute for the Study of Mental Retardation, 1970. ($1.00)

This annotated bibliography, prepared for nutritionists, contains many entries on specific nutritional deficiencies in animals as well as in humans. Two sections seem particularly relevant for educators: "Nutrition, Birthweight, and Mental Retardation" and "Nutrition, Growth, and Mental Retardation."

149. Stoch, M.B.& Smythe, P.M. Does undernutrition during infancy inhibit brain growth and subsequent intellectual development? Archives of Diseases of Childhood, 1963, 38, 546-552.

Reported are studies of malnourished Negro children in South Africa who were tested on the Gesell, Merrill-Palmer, and an African modification of the Stanford-Binet-Simon Test. Test performance was correlated with height, weight, and head circumference. Results showed a significant relationship between head size and performance of the malnourished children compared to the controls. In a second phase of the study 20 children between 10 months and three years of age were selected on the basis of markedly reduced height, weight, and head circumference. Their physical and mental development were checked periodically over approximately 11 years. During this follow-up period these children scored consistently and substantially lower than a control group by 15-20 IQ points. Educational placement of the experimental children was also reported as lagging considerably behind average for age. Even with a longitudinal study, it was difficult to separate the effects of the environment. Control children came from more stable homes with better living conditions and were attending an all day nursery school when the study began.

150. Stoch, M.B. & Smythe, P.M. The effect of undernutrition during infancy on subsequent brain growth and intellectual development. South African Medical Journal, 1967, 41, 1027-1030.

In an eleven year longitudinal study, begun in 1955, 20 "grossly undernourished" infants with no organic diseases and a normal birthweight and a nourished control group were examined and tested to ascertain the intellectual development of these children. Living conditions were worse

in the experimental group, but improved during the course of the study until they were nearly equivalent to those in the control group. The IQ's measured at various intervals during the study showed a significant difference of about 20 points between the groups. In educational placement, the undernourished group lagged far behind the control group as well as the population as a whole. The malnourished group showed significantly less initiative, a lower level of organization of play material, less fantasy affectional behavior, and more fantasy aggression.

151. Sulzer, J.L. Behavioral data from the Tulane nutrition study. Paper presented at the American Association for the Advancement of Science, Boston, December 1970. (ED 043 375, 23p.)

This exploratory study used New Orleans Head Start children as subjects, and investigated the relationship between iron anemia and psychological performance. Two hemetological measures (hematocrits and hemoglobin) were used as indices of nutritional state. In the anemic children, it was found that the chronological age (CA) incrased much faster than the mental age. Food supplement intervention was tried: some of the children were given a fortified commercial cereal for eight months. This intervention had a definite beneficial effect on blood levels of individuals who were earlier deficient.

152. Sulzer, J.L. A comparison of selected measures in normal and iron deficient children. Paper presented at the annual meeting of the American Educational Research Association, Minneapolis, March, 1970. (PS 003 675, 20p.)

A study was done during the six week summer session with Head Start children in New Orleans. The children were administered two IQ tests, two measures of cognitive development, a short term memory task, a group of reaction time tasks, a work or endurance measure, and a brief food preference test. The purpose of the study was to investigate the relationship between relatively mild levels of nutritional deficiencies and indices of psychological development and function. The findings reported were early results, and the author suggests that there would be long term effects on reading, but probably not on arithmetic or physical education.

153. Sulzer, J.L., Hansche, W.J. & Koenig, F. Nutrition and behavior in Head Start children: Results from the Tulane study. In D.J. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

Children from a summer Head Start program in New Orleans were tested with IQ and cognitive development tests. Nutritional status was also assessed. Results indicated that intellectual decrement of a generalized nature occurs primarily in children who display symptoms of both present and past malnutrition. The major sign of current malnutrition was found to be reduced attentiveness, motivation, and resistance to fatique. These findings indicate that measures of different kinds of psychological processes might be emphasized depending upon the nature of the design and whether past, current, or continuing nutritional insult is under investigation.

154. Sunderlin, S. & Wills, B. (Eds.) Nutrition and intellectual growth in children. Washington, D.C.: Association for Childhood Education International, 1969. (ED 028 570, 65p.)

Included in this discussion of nutrition and intellectual growth are two reports on hunger in America, articles on nutrition and intellectual development in children, maternal diet, growth and behavior, international nutrition and later learning, medical care of children, and a glossary. Also discussed are nutritional prospects of the future and conservation, resources, and education. (Several of the articles are abstracted elsewhere in this bibliography.)

155. Thompson, H.L. Malnutrition as a possible contributing factor to learning disabilities. Journal of Learning Disabilities, 1971, 4(6), 312-315.

Citing research studies on nutrition and the effects of particular protein and vitamin deficiencies on brain development and function, the article stresses the importance of adequate nutritional balance during the prenatal months and the first few years of life. Listed are signs which may be indicative of malnutrition and which can be recognized by teachers or parents. It is argued that if parents can be educated in proper prenatal and postnatal nutrition of their infants, and if requisite nutrients can be made available, the number of children who develop learning problems necessitating special education may be decreased.

156. Tizard, J. Cultural deprivation and mental handicap. Nursing Mirror, 1969, 128(17), 32.

A brief discussion is presented on the effect of poor social and environmental conditions, including malnutrition, on the developing child.

157. Tobias, P.V. Brain size, grey matter, and race--fact or fiction? American Journal of Physical Anthropology, 1969, 32, 3.

A critical review is given of those factors which may be accompanied by variations in brain weight, sex, body size, age of death, nutritional state in early life, sources of the sample, occupational group, cause of death, lapse of time after death, anatomical level of severance, presence or absence of cerebrospinal fluid, of meninges, and of blood vessels. Valid comparisons between brain weight of human populations should take some or all of these variables into account; published studies have not done so, despite claims to the contrary. The ideal brain sample is from children who have died suddenly without prior disease. Three such samples are on record for Europeans, but none has been recorded for Negroes. The brain weight of healthy Negroes is not known. It is concluded that vast claims for interracial differences have been based on insubstantial evidence.

158. Underfeeding and brain development. Nutritional Reviews, 1967, 20(1), 332.

There is much interest today in possible nutritional influences on the mental performance of children. Undernourished children show a retardation in physical growth. The question is whether there is a comparable effect on psychomotor growth and if so, whether this might not account for some of the "backwardness of the underprivileged peoples"--a contribution to what has become known as the "culture of poverty". It is well known that deficiencies of certain vitamins, thiamine, niacin, phridoxine, can result in central nervous system symptoms.

159. Undernutrition in children and subsequent brain growth and intellectual development. Nutrition Review, 1968, 26(7), 197.

This article presents a review of the longitudinal study conducted by Stoch and Smythe in South Africa. Evidence is presented that severe undernutrition during the first two years of life is associated with brain size and intellectual development that are below average. Further studies are necessary to separate nutrition from other possible causative factors.

160. U.S. Senate: Select Committee on Nutrition and Human Needs, The food gap: Poverty and malnutrition in the United States. Washington, D.C.: U.S. Government Printing Office, August 1969.

The findings this committee are concerned with are the effects of hunger and malnutrition and child development. Apathy, listlessness, loss of energy and ability to concentrate, slowness of comprehension, inattention, restlessness, behavioral problems, and retarded learning were suggested as some of the cognitive and psychological outcomes of malnutrition. General retardation in mental and physical growth was also evidenced in the malnourished children. It is suggested that undernutrition may be the primary cause of diminished intellectual achievement among poor American children. Sections of the report include evidence of the effects of malnutrition, the food-income gap, and a plea for food program reform.

161. Van Beukering, J.A. Undernutrition during infancy and the effect of brain growth and intellectual development. South African Medical Journal, 1967, 41, 1179.

Based on observations at concentration camps and the subsequent development of the camp occupants the author suggests that hereditary factors are more important than undernutrition in intellectual development in infancy.

162. Vernon, P.E. Intelligence and cultural environment. New York: Barnes and Noble, 1970. ($7.25)

This book explores environmental and cultural factors that hinder intellectual development in either underdeveloped countries or depressed minority groups. Part I investigates the concept of intelligence, its genetic determinations, its childhood development, and the validity of a general concept of intelligence, especially when different cultural groups are compared. Part II surveys experimental evidence pertaining to major environmental influences on intellectual development and on other factors such as nutrition, degree of childhood stimulation, family, and socioeconomic and school conditions, especially in the United States and Britain. Part III is concerned with problems of psychological test applicability in different cultural groups. Part IV describes a group of tests assembled by the writer and the scores on these tests obtained from administration in Britain. An assortment of tests of varied abilities was given to small samples of boys aged 11 years. Part V briefly sketches overseas groups of 11 year old boys who were tested, and then analyzes the main handicaps thought to affect development of the boys' intelligences. Cultural groups studied included children from Jamaica and Uganda, and Canadian Indians and Eskimos.

163. Wagner, M.G. Nutrition and mental development. East Lansing: Michigan State University, Head Start Evaluation and Research Center, Research Report #5, November 1969. (ED 037 252, 35p.)

The dietary appraisals, biochemical evaluations, and anthropometry used to assess the nutritional status of 60 disadvantaged Negro five-year-old children disclosed few, if any, nutritional deficiencies. Low levels

of nutrient intakes revealed by the analyses of 24-hour food intake interviews were not reflected in the biochemical findings which were above minimum levels with very few exceptions. The author suggests that if a nutritional insufficiency existed in the sample of children, it was at a level that permitted physiological adaptation by the child so that growth was not appreciably affected. Correlations between physical measures and intelligence test scores showed a positive relationship between height and psychological performance test scores in boys, but not in girls. The author suggests that the results imply that factors other than nutrition exert a more profound influence on mental development.

164. Waisanen, F.B. & Fonseca, E.T. Social stratum and restricted life changes. In D.J. Kallen (Ed.) Nutrition, development, and social behavior. Washington, D.C.: U.S. Government Printing Office, in press.

The purpose of the paper was to examine some of the elements dealing with context and process that bear upon the remedial possibilities of the effects of malnutrition. Malnutrition is largely a consequence of poverty, and poverty is the consequence of restricted power. Restricted power tends to produce a life that perpetuates the restricting circumstances and debilitating consequences. Social status is suggested as being important in the opportunities available for overcoming malnutrition, poverty, and its effects.

165. Walker, A.R., Richardson, B.D. & Walker, B.F. Nutrition and intelligence. South African Medical Journal, 1970, 44, 717-718.

The authors suggest that the relation of nutrition to intelligence is still very much open to question. Adequate tests and confounding

factors are compounding problems. Animal studies may provide valuable leads, but not conclusive evidence which can be extrapolated to man. While present evidence does not suggest that major portions of the world's population have suffered irreversibly mental damage, nations should do their utmost to provide adequate nutrition for infants. Education, remediation, and research must be implemented together.

166. Weiner, W.G. The relationship of birthweight and length of gestation to intellectual development at ages 8 to 10 years. Journal of Pediatrics, 1970, 76(5), 694-699.

Longitudinal data from the Johns Hopkins Study of Premature Infants were analyzed to compare the postnatal mental development of "small for dates" infants with that of other low birth weight newborn infants. At ages eight to ten years the IQ scores in children of the two groups were not different. Infants who weighed more than 2500 grams at birth and whose mothers reported a gestational period of less than 38 weeks had significantly lower IQ scores at ages eight to ten years than children who were reportedly born at term with birth weights of more than 2500 grams. Nutritional implications are discussed.

167. Werner, E.E. & Muralidharan, R. Nutrition, cognitive status, and achievement motivation of New Dehli nursery school children. Journal of Cross Cultural Psychology, 1970, 1(3), 271-281.

Significant differences in IQ measures and motor development were found between twenty-four inadequately and sixteen adequately nourished New Dehli preschool children from lower middle class homes. The former showed greater variability than the latter, and girls in the former category had lower mean scores than boys in the latter.

168. Wheeler, R.M. The challenge of hungry children. Washington, D.C.: U.S. Department of Health, Education, and Welfare, Office of Education, 1967. (ED 014 359, 8p.)

During the past twenty years, thousands of Negro farm laborers in Mississippi have been displaced by advanced technological changes in the field of agriculture. Many of these people live in extremely poor housing, exist on vitamin deficient diets, and are surrounded by a sea of filth and debris. Disease runs rampant among the children because their undernourished bodies have low resistance, and medical services are not readily available. Although two federal food programs are provided, there are many instances where neither of the programs is adequate. For children who suffer malnutrition in early childhood, there is little chance of normal mental and physical development. They are denied the hope of developing their human potential for competing in the complex and demanding society in which they must live. It should be remembered, too, that the conditions of the poverty-stricken people of Mississippi are not limited to that state, but exist in many other areas throughout the United States, and while the federal government is capable of solving these problems, it will fail to do so until the prevailing political resistance is overcome.

169. Widmer, E.M. The critical years: Early childhood education at the crossroads. Scranton, Pa.: International Textbook, 1970. $5.50.

Designed for teachers, the text offers a clarification of values and practical program content for early childhood education. A portion of the book is devoted to a brief history of early childhood from a modern theoretical approach, issues and controversies of concern today, and similarities and differences between early childhood education and elementary

school education. Also included are sections on the early childhood developmental period, such as concept formation and its role in childhood thinking and learning, an analysis of the cognitive levels of development, the role of nutrition, consideration of the special problems found when dealing with children of physical and emotional poverty, and a discussion of curriculum itself and program design for the early years.

170. Willerman, L. & Churchill, J. Intelligence and birth weight in identical twins. Child Development, 1967, 38(3), 623-629.

Two groups of identical twins, 5-15 years old, were given an IQ test. One group, racially mixed, was from a lower socioeconomic class than the other, which was all white from a middle class. In both groups the members of pairs with the lower birth weights had lower verbal and performance IQ's. One interpretation of the results was that nutrient supplies may be inadequate for proper body and brain development in twin pregnancies and the unequal sharing of nutrients stunts one twin more than his mate.

171. Winick, M. Biological correlations. Diseases of Children, 1970, 120, 416-418.

At present, there is too little data from studies correlating the biochemical changes observed in the brains of malnourished animals, or children who die of malnutrition, with the functional changes observed in these same animals or similar children who survive a period of severe malnutrition during early infancy. Winick reports preliminary findings of a study being carried out jointly between the Departments of Pediatrics at Cornell University and the University of Chile. Severely marasmic infants under six months of age who died before nutritional rehabilitation

could take effect are compared with controls (Chilean children who died of accidents, poisonings, or crib deaths). The brains of the 14 marasmic children who died showed reduced wet weight, protein, DNA and RNA content. Other biochemical measures showed deficiencies among the experimental group. Thirty-three children who survived and 16 control children were followed; at the time of data compilation, they were 2 1/2 to 5 years of age. At this time 70% of the malnourished children had head circumferences below the tenth percentile and more than 50% were below the third percentile for normal Chilean children. Ninety-one percent of the malnourished children remain limited in their capacity to adapt to the environment, so that 51.4% are educable only with a special teaching system; 36.4% are trainable, to simple physical tasks; and 36.4% require custodial care. The functional deficits appear to be irreversible.

172. Winick, M. Cellular changes during placental and fetal growth. American Journal of Obstetrics and Gynecology, 1971, 109(1), 166-176.

During prenatal growth, the organs of the fetus are all in the proliferative phase. Evidence in animals demonstrates that severe maternal protein restriction will curtail cell division in all fetal organs including the brain. In contrast the placenta goes through all three growth phases in utero. Stimuli will affect cell division if applied before the seventeenth day of gestation in the rat and will affect cell enlargement if applied thereafter. Changes in the cellular growth pattern of the placenta may therefore be indicative of the time a stimulus has been active. For example, maternal diabetes in the human results in a placenta with an increase in the number of cells, indicating that whatever

has been stimulating growth has done so before the 35th week when cell division usually stops in the human placenta. By contrast, intrauterine growth failure in general and maternal malnutrition in particular will curtail cell division in the placenta. Limited data suggest that children who are under 2,000 grams at birth will sustain greater cellular damage than larger infants when both are subsequently exposed to postnatal malnutrition. The "full-term" infant who dies during the first year of life from severe nutritional marasmus will have a 15% deficit in total brain cell number. In contrast, the low birth weight infant may show a deficit of up to 60%. A number of problems have yet to be resolved. The extent of the nutritional deprivation necessary to produce these changes is unknown. The mechanism of curtailment of cell division has still to be worked out.

173. Winick, M. Cellular growth during early malnutrition. Pediatrics, 1971, 47(6), 969-978.

Available data demonstrate that postnatal undernutrition during the period of proliferative brain cell growth will retard the rate of cell division regardless of the region or cell type and result in a permanent reduction in brain cell number. Prenatal malnutrition in the rat will do precisely the same thing and combined prenatal and postnatal undernutrition will act synergistically, producing a profound reduction in brain cell number. Human maternal undernutrition can retard the rate of cell division in the placenta. There are some data to suggest that combined prenatal and postnatal undernutrition in the human will also act synergistically. It is important to note that although the timing may be similar, there are no data as yet which demonstrate any causal relation-

ship between the chemical changes discussed in this paper and the psychological changes which have been reported both in animals and in children resulting from early malnutrition. However, regardless of the functional correlates, the data demonstrate that severe malnutrition early in life can permanently impede cell division and myelination in the developing brain.

174. Winick, M. Cellular growth in intrauterine malnutrition. Pediatric Clinics of North America, 1970, 17(1), 69-78.

Regional growth in the human brain is somewhat different than in the rat brain. Cell division stops at about the same time in the cerebellum (8-10 months), cerebrum, and brain stem. Severe malnutrition during this proliferative phase retards cell division in all three of these regions. The rate of cell division is about the same in the cerebellum and cerebral cortex, and both are severely affected by malnutrition. In comparison to the rat, cell division in the human cerebrum is much more affected by postnatal malnutrition. Thus, postnatal malnutrition curtails cell division in the human brain as it does in the rat brain. Prenatal stimuli affect the human placenta in much the same way as in the rat placenta. Although at this time human fetal data are still sketchy, the suggestion that cell division in fetal organs can be curtailed by maternal undernutrition appears to be valid enough to require further studies. In view of the tremendous public health implications of this possiblility, and in view of the evidence in animals which demonstrates that these changes are permanent, it would seem that every effort should be made to confirm or rule out the possibility that undernutrition of the mother may permanently reduce the number of brain cells in her offspring.

175. Winick, M. Fetal malnutrition. Clinical Obstetrics and Gynecology, 1970. 13(3), 526-541.

In this article the problem of fetal malnutrition has been viewed from the standpoint of any condition which will reduce the final quantity of nutrients reaching the fetus. Both maternal vascular insufficiency and maternal undernutrition have been examined. In experimental animals both of the conditions will retard cell division in the placenta if imposed during the hypertropic phase. By contrast, cell division in all fetal organs is impaired no matter when the stimulus begins. In humans, both maternal vascular disease and maternal undernutrition will impede placental cell division. Evidence derived from studying infants who have died after postnatal malnutrition suggests that the curtailment of cell division in their brains might have been augmented if they were malnourished during fetal development. These data highlight the importance of increasing the research efforts in the area of fetal malnutrition.

176. Winick, M. Fetal malnutrition and growth processes. Hospital Practice, 1970, Pp. 33-41.

When growth is studied in cellular terms, it becomes clear that it is not a homogeneous process but that an organ moves from a stage in which growth is by increase in cell number to one of growth by increase in cell size. Undernutrition during the first stage may leave a permanent deficit in cell number. Completing its growth first, the brain is at severe risk from fetal malnutrition.

177. Winick, M. Food, time, and cellular growth of brain. New York State Journal of Medicine, 1969, 69(2).

An animal or an individual organ exhibits an early period of growth by rapidly increasing its number of cells. It is during this period that the animal or organ is most sensitive to the state of nutrition. Undernutrition will curtail the rate of cell division; "superfeeding" will increase the rate. Optimal feeding will reverse the effects of restriction only if begun during this period. In the rat, by the time of weaning, cell division has stopped in the brain. In the human being, by six months of age the total number of brain cells has been reached. Malnutrition during these critical periods results in a reduced number of brain cells in both the rat and the human infant.

178. Winick, M. Malnutrition and brain development. Journal of Pediatrics, 1969, 74(5), 667-679.

Pertinent studies concerned with nutritional deprivation and brain development are examined critically and the results interpreted. It is concluded that evidence is piling up to show that malnutrition in infancy does permanent damage and that the earlier the malnutrition, the more severe and permanent are the effects. The data suggest that if malnutrition begins to occur after a certain age, the effects are reversible. Also, an infant born to a malnourished mother is more at risk than one born to a well nourished mother. It is recommended that the first priority should be the elimination of malnutrition in infants and possibly even prenatally.

179. Winick, M. Nutrition and intellectual development in children. In Nutrition and intellectual growth in children. Washington, D.C.: Association for Childhood Education International, 1969, Pp. 25-32.

This article deals with various studies of animals in various stages of malnutrition. The first type demonstrates chemical changes in the brain permanently induced by malnutrition early in life. The second group of investigations (some with children) attempts to deal with the effects of

malnutrition on intellectual development. These studies are difficult to conduct with children because of ethical considerations. Studies are therefore naturalistic rather than experimental.

180. Winick, M. Nutrition and mental development. Medical Clinics of North America, 1970, 54(6), 1413.

Poverty and malnutrition are parts of a vicious cycle and often prevent families from adequately nourishing their infants and young children. Children, therefore, often fail to realize their full intellectual potential. Available evidence from human studies reinforces the data derived from animal experiments and suggests that there is a critical period of brain growth during early infancy when the brain is extremely vulnerable to the effects of malnutrition. It has been found that the earlier the nutritional deprivation, the more severe the retardation. Both animal and human data suggest that prenatal malnutrition may make the brain more vulnerable to a subsequent postnatal insult.

181. Winick, M. Nutrition and nerve cell growth. Federation Proceedings, 1970, 29(4).

Early malnutrition in rats retards cell division in any brain area in which proliferation is occurring and permanently affects any cell type proliferating. Migration of cells is delayed, synthesis of myelin is retarded, and the pathway of glucose metabolism is altered. In humans also, the cell division is curtailed by early malnutrition. Later malnutrition will reduce the size of individual cells but not the number of cells. A theory is presented which offers a general explanation of how malnutrition and other stimuli may affect cellular growth differently at different times.

182. Winick, M. & Rosso, P. The effect of severe early malnutrition on cellular growth of the human brain. Pediatric Research, 1969, 3, 181-184.

Reduction in DNA, RNA, protein, cell number, brain size, and head circumference was found in infants who had experienced severe malnutrition throughout their lives. These changes were even more marked in children who had experienced malnutrition both prenatally and postnatally. The greatest effect on the central nervous system occurs during the last trimester of pregnancy and the first six months of life.

183. Winick, M. & Rosso, P. Head circumference and cellular growth of the brain in normal and marasmic children. The Journal of Pediatrics, 1969, 74, 774-778.

Increases in head circumference accurately reflect brain growth during the first year of life. During severe malnutrition the normal rate of increase in head circumference is reduced. Similarly, there is a curtailment in the normal increase in brain weight, protein, and DNA content. The reduced circumference is directly proportional to the reduced brain weight and protein content, DNA content is usually more affected than head circumference. Thus, the degree of reduction in head circumference is a useful clinical tool, since it accurately reflects cellular growth patterns in the brains of normal and malnourished infants.

184. Winick, M. & Rosso, P. Malnutrition and cellular growth in the brain. Paper presented at the Eighth International Congress of Nutrition, 1969, Exerpta Medica International Congress Series No. 213, 531-538.

Early malnutrition in rats retards cell division in any brain area in which proliferation is occurring and permanently affects any cell type proliferating. Migration of cells is delayed, synthesis of myelin is

retarded and the pathway of glucose metabolism is altered. In humans, also, cell division is curtailed by early malnutrition. Later malnutrition will reduce the size of the individual cells but not the number of cells. Again, those areas in which cells are most rapidly proliferating are the areas most affected by undernutrition. In the human, however, cerebrum is such an area and cell division is profoundly curtailed in early malnutrition in the human cerebrum when compared with the rat cerebrum. The brain stem is also more markedly affected in the human than in the rat. These differences in the effect of severe early malnutrition on the regional brain growth in rats and humans may in part explain some of the differences in brain function produced by undernutrition in the two species. In the living patient, head circumference appears to be a good measurement of total brain mass during the first year of life. Moreover, the reduction in head circumference seen in marasmic children reflects proportional reduction in total brain mass and total brain cell number.

185. Winick, M., Rosso, P. & Waterlow, J. Cellular growth of cerebrum, cerebellum and brain stem in normal and marasmic children. Experimental Neurology, 1970, 26, 393-400.

The pattern of cellular growth during the first two years of life has been studied in the human cerebrum, cerebellum, and brain stem from normal and marasmic children. In normal children there is a linear increase in wet weight, dry weight, total protein, and total RNA in all three regions throughout the first two years of life. In contrast, DNA content increases rapidly in the cerebrum to about 6-8 months of age, and in the cerebellum until 8-10 months, with very little increase thereafter. In the brain stem, DNA

content increases more slowly until about one year of age with little increase thereafter. Children who died of severe marasmus demonstrated reduced wet weight, dry weight, protein, RNA, and DNA in all three regions. The reductions in DNA content (cell number) are approximately equal in the cerebrum and cerebellum and of much greater magnitude in these two parts than in the brain stem. These data demonstrate that malnutrition in early life will retard the rate of cell division and reduce the ultimate number of cells in the human cerebrum, cerebellum, and brain stem. The data from this study reveal different regional growth patterns and different regional effects of malnutrition in the human brain than those which have been previously reported in the rat brain. These differences have raised some questions as to the suitability of the rat as a model for studying the effects of malnutrition on cellular growth.

186. Witkop, C. Genetics and nutrition. Federation Proceedings, 1967, 26, 148-150.

Essentially what is proposed here is a testable hypothesis: a) that a possible mechanism for a large component of mental retardation in protein-malnourished infants and young children is the result of nutritionally induced enzymatic deficiencies; b) that the type of mental retardation expected would have the clinical features of histidinemia and phenylketonuria; c) that children born to protein-malnourished mothers would have a mental defect quantitatively and qualitatively different from the child who had only postweaning protein-malnutrition; and d) that if the histidine block is sufficiently severe these children would be expected to exhibit short

auditory memory span which would induce a specific type of learning disability. If it is found that protein malnutrition does have the features of histidinemia with short auditory memory span, it has far-reaching implications on teaching methods of protein-deprived areas.

187. Yatkin, U.S. & McLaren, D.S. The behavioral development of infants recovering from severe malnutrition. Journal of Mental Deficiency Research, 1970, 14(1), 25-32.

The relationship of nutritional status and behavioral development was investigated in two experimental groups of infants recovering from severe marasmus. Stimulated and unstimulated groups differed in their environmental conditions of hospitalization during recovery, but received the same medical and nutritional care. The degree of responsiveness to the environment was assessed eight times by the Griffiths Mental Development Scale applied every two weeks throughout the hospitalization period of four months. The results showed that improvement in the nutritional state is associated with marked and steady increase in the Developmental Quotient (DQ). The stimulated group showed a significantly greater improvement than the nonstimulated group. Both groups, however, failed to attain the normal quotients by the end of rehabilitation. Thus, while malnutrition during early childhood may cause profound retardation in development and behavior, it is clear that the environmental stimulation, as well as the medical and nutritional care provided during hospitalization is an important factor in the speed and degree of recovery. Significant correlations were found between DQ and weight, and DQ and head circumference. The five mental functions composing the DQ improved to varying degrees, with

hearing and speech most affected at discharge. The superior performance of the stimulated group involved each of the five mental functions.

Author Index

Abednego, B. 92
Abelson, P.H. 15
Adams, R.N. 15
Adinolfi, A.A. 60
Aldrich, R.A. 16
Altman, J. 16
Babayan, S. 24
Balit, H. 17
Bakan, P. 17
Barnes, R.H. 18, 19
Barrera, Moncada, G. 19
Benton, A. 20
Birch, H.G. 20, 21, 22, 23, 24, 37, 39
Bossio, V. 88
Botha-Antoun, E. 24
Brockman, L.M. 25, 26
Bronfenbrenner, U. 26
Brown, A.M. 27
Brown, R.E. 27
Brozek, J. 28
Bullard, D.M. 28, 50
Cabak, V. 28
Canosa, C.A. 29
Carter, J. 30
Champakam, S. 31
Chandra, R.K. 32
Chase, H.P. 32
Chaves, N. 33
Chow, B.F. 91
Churchill, J.A. 33, 103
Cobos, F. 33, 34, 64

Coursin, D.B. 34, 35
Cravioto, J. 23, 35, 36, 37, 38, 39, 40, 41
Culley, W.J. 41
Das, G.D. 16
Dayton, D.H. 41
Dean, R.F. 42
DeLicardie, E.R. 37, 38, 39
Dobbing, J. 43
Dominquez, A.M. 44
Eichenwald, H. 45
Eisenberg, L. 46
Evans, D.E. 46
Fonseca, E.T. 100
Foster, F.P. 47
Found, R.E. 57
Freeman, H.B. 88
Fiedman, S.B. 47
Frisch, R.E. 48
Fritz, M.F. 48
Frost, J.L. 49
Fry, P.C. 45
Gaona, C. 40
Garrow, J.S. 50
Gates, A.I. 54
Giok, L. 65
Glaser, H. 50
Gopalan, C. 31
Gordon, J.E. 51, 90
Graham, G.G. 51
Granoff, D. 81
Grotberg, E.H. 23, 52
Guevara, L. 34
Gussow, J.D. 24, 52
Gutelius, M.F. 52

Gyorgy, P. 53, 54
Habicht, J.P. 61
Halpern, F. 27
Hansche, W.J. 95
Hansen, J.D. 46
Harfouche, J.K. 24
Harrell, R.F. 54
Heagarty, M. 50
Hegsted, D.M. 55
Hie, T. 65
Hormazabal, J. 87
Jan, O. 65
Jelliffe, D.B. 56
Jelliffe, E.F. 56
Jervis, G.A. 56
Johnson, N.E. 57
Kallen, D.J. 57, 58, 59
Kanawati, A.B. 69
Karjod, D. 92
Katz, M.M. 62
King, L.S. 59
Klein, R.E. 29, 59, 60, 61, 62
Kline, O.L. 54
Koenig, F. 95
Kubala, A.L. 62
Kugelmass, I.N. 63
Latham, M.C. 63, 64
Leverton, R. 64
Liang, P. 65
Martin, H.P. 32
Matheny, A.P. 27
McKay, A.C. 67, 68
McKay, H.E. 67, 68
McLaren, D.S. 69, 113
Mickelson, O. 70

Monckeberg, F.E. 71, 72, 73
Moodie, A.D. 46
Moore, A.U. 19
Moore, W.M. 74
Munro, N. 74
Muralidharan, R. 101
Naeye, R.L. 75
Najdanvic, R. 28
North, A.F. 75, 76
Osofsky, H. 77
Owen, G.M. 78
Payne, B.L. 49
Pekerti, A. 92
Pike, M.C. 50
Pirchik, E. 50
Pollitt, E. 79, 80, 81, 82
Pond, W.G. 19
Poull, L.E. 63
Rajalakshmi, R. 83
Read, M.S. 84, 85
Reid, I.M. 19
Rendon, R. 85
Riccuiti, H.N. 26, 82, 86, 87
Richardson, B.D. 100
Robles, B. 40
Romero, E.D. 88
Rosales, L. 37
Rosso, P. 87, 110, 111
Salomon, J.B. 29
Samuel, E.L. 63
Sandstead, H.H. 88
Schlenker, J.D. 88

Scrimshaw, N.S. 51, 89, 90
Simonson, M. 91
Sinisterra, L. 67, 68, 91
Smythe, P.M. 93
Soewondo, S. 92
Springer, N.S. 92
Srikantra, S.G. 31
Stoch, M.B. 93
Sudarshan, K. 16
Sulzer, J.L. 94, 95
Sunderlin, S. 95
Taylor, C.E. 90
Thompson, H.L. 96
Tizard, J. 96
Tobias, P.V. 97
Van Beukering, J.A. 98
Vega, L. 37
Vernon, P.E. 99
Wagner, M.G. 99
Waisanen, F.B. 100
Walker, A.R. 100
Walker, B.F. 100
Waterlow, J. 111
Weiner, W.G. 101
Werner, E.E. 101
Wheeler, R.M. 102
Whelan, M.A. 17
Widmer, E.M. 102
Willerman, L. 103
Wills, B. 95
Winick, M. 87, 103, 104, 105, 106, 107, 108, 109, 110, 111
Witkop, C. 112
Woodyard, E. 54
Yarbrough, C. 61
Yatkin, U.S. 69, 113
Zanderzwaag, R. 88

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